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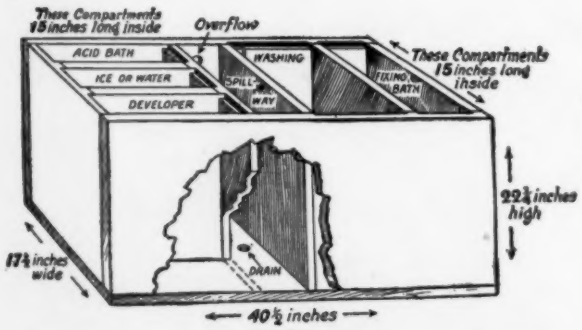

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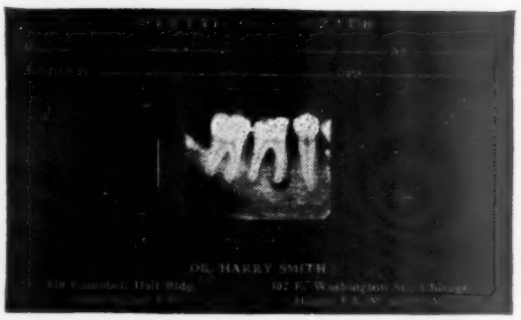

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THE AMERICAN JOURNAL OF ROENTGENOLOGY

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BONY CHANGES IN FEET FOLLOWING FRACTURE OF THE VERTEBRAE

By LLOYD BRYAN, M.D.

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BONY changes associated with nerve lesions are of frequent occurrence. The most common of these are the so-called Charcot joints—the changes in the phalanges, metacarpals and metatarsal bones in leprosy, and in cases of syringomyelia. Also Eloesser experimentally produced typical Charcot joints in cats by severing the posterior nerve roots and allowing the animals to traumatize the joints.

Little attention has been given to the fact that fracture of the vertebrae followed by sensory disturbance in the legs and feet may also be accompanied by bony changes. Therefore, I wish to present the following two cases as being of some interest to the roentgenologist.

PHILIPPINES.

CASE 1.—H. H., age forty-four, native of Germany; painter by occupation; family history of no importance. He served with the American army in the Philippines for two years between the ages of twenty-three and twenty-five, and while there had malaria. Twelve years ago he had a rather severe attack of "painter's colic." Eleven years ago he fell from a scaffold three stories high upon a concrete sidewalk, fracturing his left wrist and injuring the spine. Following the accident, there was paralysis of both legs with incontinence of urine and feces, and loss of sensation in the penis and in the lower legs. The use of his legs was restored in about a month. Within a few weeks, the bladder and rectum functions were practically normal. There is now occasional difficulty when the bladder is distended, and there is also at rare intervals, incontinence of stool. The sensory disturbance in the feet and legs has not improved.

Physical examination shows no variation from the normal in the head, upper extremities, chest or abdomen; there is a slight kyphosis in the upper lumbar spine, with some limitation of motion. The thighs and knees are normal. The lower legs show muscular atrophy and the toes show plantar flexion; the second and third digits on the right foot were amputated on account of contractures three years ago, and the fourth digit on the left foot was amputated one year ago. There is a small ulcer on the plantar surface of the left foot at the base of the fifth digit. There is marked diminution of the tactile and pain sense in the penis and scrotum and around the anus, also on the posterior central region of the left thigh, and the entire left foot and ankle; on the

*Read before the Pacific Coast Roentgen Ray Society, December 6, 1919.

FIG. 1. CASE 1. LATERAL PLATE SHOWING CRUSHING FRACTURE OF THE FIRST LUMBAR VERTEBRA.

FIG. 2. CASE 1. ANTERIOR POSTERIOR PLATE SHOWING CRUSHING FRACTURE OF THE FIRST LUMBAR VERTEBRA.

right side there is loss of sensation of the medial and posterior surface of the thigh and of the lateral posterior surface of the lower leg and the entire foot and ankle.

Roentgen examination shows a crushing fracture of the body of the first lumbar vertebra.

The astragalus of both ankles shows a flattening, with slight thickening about the superior articular surface, and a small loose fragment on the right side.

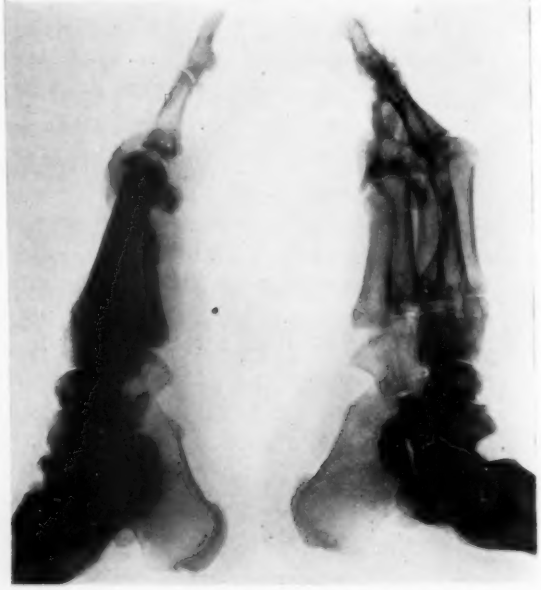

FIG. 3. CASE 1. LATERAL VIEW OF BOTH ANKLES.

The left foot shows an amputation through the middle of the proximal phalanx of the fourth digit; the remainder of the phalanx is sharpened and there is a dislocation of the metatarsal phalangeal articulation.

There is also a dislocation of the third metatarsal phalangeal articulation, and there is erosion of the distal end of the proximal phalanx with a sharp spur on the lateral surface of the distal end.

The proximal phalanx of the fifth digit shows erosion of the base with slight tendency to hypertrophic change, with the distal end of the proximal phalanx narrowed and somewhat irregular as though a partial absorption had occurred.

The right foot shows an amputation of the second and third phalanges at the metatarsal-phalangeal joint; there is erosion of the head and distinct thinning and slight irregularity of the distal thirds of the shafts of the fourth and fifth metatarsals. The proximal phalanges of both these digits are markedly thin and pointed, as if partially

absorbed. There is also marked erosion of the base of the middle phalanges of these digits. Aside from the astragalus, there is no change in the tarsus or in the metatarsals, except as mentioned. The distal phalanges of all the digits remaining are normal.

FIG. 4. CASE 1. LEFT AND RIGHT FEET.

The roentgenograms of the hands are normal, except for old fracture of the right scaphoid.

Here, then, we have a destructive process or a process of absorption with tendency toward hypertrophic changes about the joints.

CASE 2.—E. S., age thirty; laborer; single; lived in Ireland until six years ago; bridge-builder and laborer.

FIG. 5. CASE 1. HANDS.

Eight years ago, the patient fell from a scaffold upon his back, fracturing the spine, with paralysis of the left leg following. At the time of entrance to the hospital he had anesthesia of the left heel, posterior portion of the ankle, and plantar and dorsal surfaces of the lateral portion of the foot, corresponding to the cutaneous supply of the

FIG. 6. CASE 2. OS CALCIS.

external saphenous, the internal calcanean and the external plantar nerves (sacral first and second).

There was a large ulcerative area on the plantar surface of the left heel, with a sinus extending about two and one-half centimeters into the bone.

There was a kyphosis of the lower thoracic spine.

The only plate available is one of the os calcis of the left foot.

The os calcis shows marked increase in density of the lower two-thirds; the posterior plantar surface is broken up into several small fragments. There is an area of destruction extending up into the posterior portion of the os calcis. There are slight hypertrophic changes about the posterior and the plantar surfaces of the os calcis.

It will be observed that in both these cases the period since the fracture of the vertebrae has been a long one—in the first case eleven years, and eight years in the second. Both were laboring men and had continued at their work; hence there has been plenty of opportunity for trauma to the anesthetic limbs. Careful clinical examination showed no evidence of leprosy in either case.

Eloesser,[1] in his very excellent article describing his experimental work, states that trauma and lack of the warning sense

of pain are the causes of most tabic bone and joint lesions. This statement is well borne out by the results of his experiments, which showed that bone and joint lesions corresponding to those found in tabes dorsalis may be induced experimentally in the limbs of cats by severing the posterior nerve roots; the limbs subjected to the most trauma developed the most marked bony changes.

It would seem that in the cases here presented, the bony changes may be at least partially, if not wholly accounted for by the theory of repeated trauma to bones or joints lacking the warning sense of pain.

I am indebted to Dr. Harold Brunn for the privilege of reporting the first case, and to Dr. Leo Eloesser for the second.

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PERSONAL EXPERIENCE IN MILITARY ROENTGENOLOGY OVER-SEAS

By LOWELL S. GOIN, M.D.

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THE writer's overseas experience was in a Base Hospital, located at Bazeilles-sur-Meuse, which performed the major part of its service while functioning as an evacuation hospital. From the standpoint of construction, the hospital was of the standard type, composed of wooden huts and of tents, and having a normal capacity of one thousand beds, capable of an emergency expansion to two thousand beds. The emergency capacity was taxed during the most of the second period of our operation. The average length of stay of all patients was four days. Many were evacuated the same day that they were received, and a certain number of fracture cases, principally fractures of the femur immobilized in permanent apparatus, were kept for a considerable period.

The apparatus furnished to the roentgen department was of the standard Base Hospital type, and consisted of a 10 K. W. transformer, a standard tube stand, Coolidge tubes, army type horizontal fluoroscope, standard vertical fluoroscope, vertical stereoscopic plate changer, a stereoscope, an army portable or bedside unit, and all the usual accessories. The horizontal fluoroscope was fitted with a detachable stretcher top, and three such tops were furnished. They proved to be very useful in moving cases from the fluoroscpic room to the operating room, when the injury was of such a nature as to preclude excessive handling of the patient. Having only direct current, we were obliged to use a rotary converter. The only one available was much too small, and limited the output of the transformer to about 7 ma. at a 5in. gap. All of our work had to be done under these conditions; but no difficulty was experienced in producing satisfactory plates. In fact, such low milliamperage with the long exposure necessitated seems to be the ideal technique for the use of a Coolidge tube. Lacking any apparatus for immobilization, we used heavy muslin bandages fastened to the table. Even frightened Germans (and all of them believed that they were to be blinded) could be restrained with this simple device.

The roentgen laboratory was located in the operating pavilion, and was connected with the operating room, enabling us to give fluoroscopic assistance to a surgeon at any

time. When the rush of work was not too great, difficult cases were often operated on the fluoroscopic table. Fractures immobilized in permanent apparatus were examined at the bedside every two weeks without disturbing the apparatus. The army bedside unit which was used for this work was also used as an auxilliary transformer during periods of stress.

Our service may be divided into three periods. In the first, extending from May to July 15th, we functioned as a Base Hospital, and the character of our work did not materially differ from that of any large hospital. All the patients received had had previous treatment; many were convalescent, and practically none required immediate *x*-ray or operative treatment. In the second period, extending from July 15th to some time after the signing of the armistice, we functioned as an evacuation hospital. Practically all our work was done during this period. Daily reception of two or three hundred patients was common, and we received during one twenty-four hour period, 894 patients. The wounded were received directly from the aid stations, and nearly all required immediate operation. We were thus compelled, without notice, to change our entire system of receiving and handling patients. The plan adopted was as follows: The wounded were received in a shed called the receiving ward, adjoining which were some tents for the overflow, and the delousing plant. Here the patients were sorted by a surgeon detailed for this purpose, and those who required immediate operative interference were sent directly to the fluoroscopic room, where foreign bodies were localized, and fractures were reported. In order to permit the stenographer to record the findings, and to avoid turning on a white light, we cut a window in the wall of the fluoroscopic room. One side of it was covered with blue cloth, and the other side with red cloth. No light passed through this window, but the stenographer sitting beside it in the next room could plainly hear the ordinary voice. The fluoroscopic report was pinned to the patient's clothes as he passed into the operating room.

The localization methods used were the Strohl method, the Hirtz compass, and the near-point method. The Strohl was the one commonly employed, and we found it to have many advantages. With a foreign body near the surface, the near-point method is simple and fairly accurate. The Hirtz compass is really not a localizing instrument, but one for the guidance of the surgeon during operation—an instrument by means of which the roentgenologist transfers his findings to the surgeon. When carefully set up it is of great assistance to the operator, and is a nearly infallible guide. We found the fluoroscopic method of setting the compass to be the most satisfactory, but it has the disadvantage of requiring the presence of the compass. When used by the plate method, the making of stereoscopic plates has obvious advantages. The chart can be constructed from them as easily as from a doubly exposed plate, and the study of the plates in a stereoscope may yield valuable information. The Hirtz compass was found to be particularly useful in the regions of the head, chest and hip joint.

The fluoroscopic search for fractures has always been justly decried; nevertheless, under the stress of war surgery, it is not always possible to make plates of suspected fractures, and fluoroscopic examination becomes necessary. The writer's experience is that in skillful hands, screen examination overlooks very few fractures, even including partial fractures and those without displacement. The plate study of fractures is, however, the method of election.

In examining the wounded it was found necessary to examine the whole body, and it was not at all uncommon to find a projectile in an entirely unsuspected region, and where the patient was not conscious of having a wound. Undoubtedly, the most important thing to the surgeon was a report couched in anatomical terms rather than in centimeters, and such a report was always given if possible. In wounds about a joint,

the important thing was to determine the extent of the joint involvement. In chest wounds, the presence and degree of effusion is important. It was our experience that chest wounds (except sucking wounds) did better when no attempt was made to remove the foreign body. The effusion was removed, and the chest immobilized, but rarely was a search for the foreign body undertaken. A number of cases were observed where a foreign body in the lung substance was doing no apparent harm. Foreign bodies in the brain were usually removed. The accompanying fracture nearly always required operation, and the track of the projectile was often full of pieces of clothing, etc. In one such case a machine gun bullet entered through the right eye and was found lying point backward in the brain substance in the region of the fourth ventricle. It was removed under guidance of the Hirtz compass. The patient was making a good recovery when he was evacuated.

Altogether 13,440 patients were thus handled, of whom 4399 were examined by the *x*-ray. The total number of roentgen examinations considerably exceeds this figure, as all patients were re-examined under the same serial number. Fracture of the skull was found in 30 cases. Fracture of the skull was found once at operation when the *x*-ray findings were negative. Fracture of the skull was found in one case where it was totally unsuspected, and where there were no clinical findings. This case was verified by operation. The chest was examined with stereoscopic plates 246 times. Findings sufficient to justify sending the patient to a base for tuberculosis observation were encountered in 56 cases. Renal calculus was found in one case, in which case it was bi-lateral. Vesical calculus was found in one case. In general, the finding of pathology other than war pathology, was very rare, due, no doubt, to the careful examination these men received on entering the service.

The distribution of foreign bodies will be of interest. They were found in the head and neck in 98 cases; in the chest cavity in 23 cases; in the chest wall in 32 cases; in the abdomen in 15 cases; in the arm, forearm, wrist and hand in 374 cases; in the thigh, leg and foot (exclusive of the knee joint) in 5621 cases; in the knee joint 26 times, and in the back muscles 47 times. In one case a machine gun bullet in the abdomen was passed per rectum: the patient recovered. In another, a patient shot in the left cheek extracted a piece of shrapnel from the right side of the gum. We were considerably disturbed at not being able to find the foreign body in this case until the patient asked if the piece he had removed could be the object of our search.

We had wished to study with the *x*-ray the chests of persons suffering from the effects of gas inhalation, and were able to study 38 cases. The stress of work prevented us from going on with the study. In the few cases studied, fairly constant changes were observed. The chests observed were those of persons suffering from the inhalation of mustard gas, of phosgene, or of both. Cases of mustard gas inhalation showed a uniform increase in the width of the hilus shadows, and a very pronounced increase in their densities. Small, sharply defined areas of great density were seen throughout both lungs, but particularly in the upper half of the right lung. Those gassed with phosgene presented a very different picture. The smaller bronchioles were dilated, and there was a delicate peribronchial thickening observed. These changes were usually confined to the upper lobes, and were more in the upper right lobe. The peribronchial thickening did not extend to the periphery, nor into the apex. In a few very severe cases, marked bronchiectasis was found. This condition may have been pre-existing, though previous cough and expectoration were denied by the patients.

During the third period of our service, extending from November until February, we again functioned as a base hospital, the work being much like that in civil life, and without incident.

THE MANUFACTURE OF FILMS AND PLATES FOR USE IN ROENTGENOLOGY

By MILLARD B. HODGSON

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ROCHESTER, N. Y.

WHILE the manufacture of any type of material demands special conditions in the factory, if the material is to be turned out in the best possible form and at the same time efficiently, the making of photographic materials—such as *x*-ray plates and films—involves considerations not met with in the manufacture of many commodities. This, of course, is due to the sensitive nature of the material.

I. Manufacturing Organization

It will be remembered that the fundamental material entering into the manufacture of photographic plates and films is silver bromide, a sensitive chemical which will not only react to light but is affected by moisture, rough handling, dirt, gases and, in fact, by almost any condition where outside energy is applied. In a factory, then, given over to the manufacture of photographic supplies, it must follow that its organization and operation preclude damage from these causes. Moreover, not only must provision be made for the utmost cleanliness and care in the actual manufacture of the finished product, but separate departments must be maintained in which the various materials entering into the making of the finished product can be produced of uniform quality, for all these separate constituents have a vital influence on the nature of the completed film or plate.

Sensitive photographic material consists primarily of two elements—the support and the emulsion. The support is either glass or a composition of nitro-cellulose, and the emulsion a dried jelly of silver bromide and gelatine. The support itself has important bearings on the quality of the finished plate or film. In the case of glass of plates, it must be free from dirt and contaminating chemicals before it is coated, and of the best quality. In the case of films, all the ingredients entering into the complicated structure of the support must be such that none of them have a deteriorating influence on the sensitive emulsion—this in addition to the necessity of quality in the emulsion itself. When it is considered that some ten or fifteen materials enter into the making of film support, it will be seen that the problem involved in this case is not a simple one.

In a plant, then, in which films and plates are made and in which the aim is high average quality, it is necessary, in so far as is possible, to make not only the finished material but all the separate constituents.

If good films are to be produced—regularly—then the film support must be made too. If the best results are to be obtained, the chemicals which develop the film for the user must be made, if printing papers of the quality necessary in portrait work are to be manufactured, then the paper stock itself must be made—and so on. Or, in case a constituent material is not manufactured outright, it must be rigorously tested and modified to insure its fitness.

In reality such a plant becomes an organization of smaller plants, each contributing its particular material made under as nearly ideal conditions as possible.

Back of this factory organization there must also be maintained a Research Laboratory where special consideration may be given to all the elements entering into the manufacture of the finished product or its constituent parts. There must be departments where the chemical nature of each of the materials used may be studied and where the reaction of one material with another may be found. There must also be a depart-

ment where such troubles as markings and defects may be taken up, their nature analyzed and remedies suggested. Finally, for progress, there must be exhaustive research on the fundamental problems relating to improvements and new methods.

trometer. This interesting instrument is also being adapted for the study of the many crystal formations possible in the making of silver bromide, which, as has been explained, is the basic constituent of emulsions. Methods have also been devised in this depart-

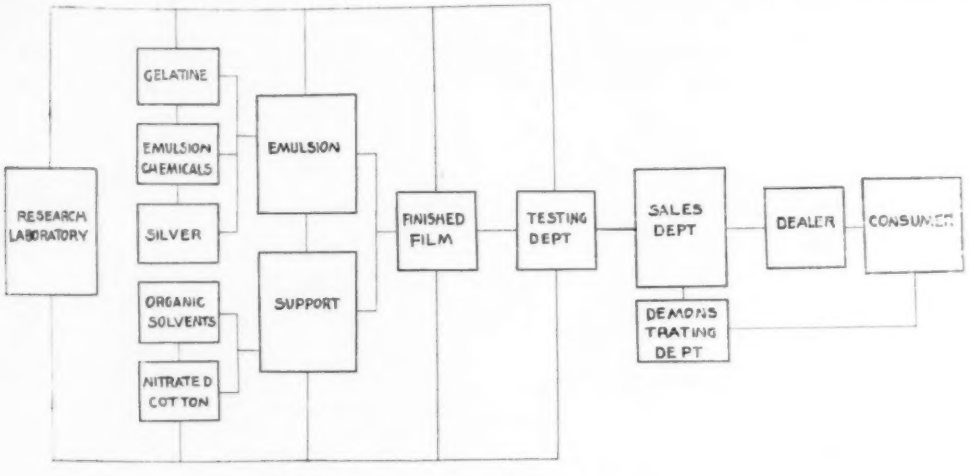

FIG. 1

There must be, in addition to the Research Laboratory, a Testing Department where the final checks on the finished products are made—under practical conditions—before they are released for sale.

The organization of such a plant may be best seen by the photograph shown in Fig. 1, which represents essentially the plan followed by the Eastman Kodak Company of Rochester, N. Y.

There are, of course, special departments which have grown up as the demand for special material developed. Such, for instance, is the *X*-ray Department. As an auxiliary to this there has also been established in the Research Laboratory a department of *x*-ray research. Here not only are the problems of roentgenology taken up with a view toward simplifying methods and developing sensitive materials and accessories which will help those methods to be efficient, but broader questions entering into the scientific development of *x*-ray science studied. For example, for studying the wave-length susceptibility of emulsions adaptable for roentgenology, considerable research has been done with the *x*-ray spectrometer for the quantitative study of the reaction of the photographic plate to *x*-rays. The *x*-ray sensitometer, described in "The Sensitometry of Roentgenographic Materials," by Millard B. Hodgson (December, 1917, issue of THE AMERICAN JOURNAL OF ROENTGENOLOGY), was developed in this department.

II. THE MAKING OF FILMS

To the uninitiated a piece of photographic film represents nothing more than a material on which pictures may be taken, but the steps entering into the manufacture of this finished sensitive material—whether it is in the form of Dupli-Tized films, dental films, motion picture films or ordinary Kodak films—form one of the most striking examples of what may be evolved in chemical, physical and mechanical processes.

The period before the days of motion pictures is well within the memory of most roentgenologists. When one stops to consider that not only this modern institution of motion pictures but the science of dental roentgenology was made possible by the

invention of photographic film, these processes acquire an almost romantic interest.

Dental roentgenology was begun by the use of plates but was very greatly facilitated by films.

Many diversified products enter into the manufacture of each of these types of films. For example, few people realize that thousands of bales of cotton are required yearly for the making of the thin transparent backing on which the light sensitive coating is spread, or imagine that some three tons of silver bullion are used each week in the Kodak plant for making this sensitive coating. The yearly consumption is nearly five million ounces, or almost as much as the total output of silver from Arizona, one of the leading silver producing states of the Union. In addition there are sulphuric and nitric acids for use in nitrating the cotton, and organic solvents for converting the nitrated cotton into a honey-like fluid from which the thin film is made, and lastly the gelatine and chemical compounds for making the sensitive coating.

For the convenience of analyzing the various steps taken in the manufacture of Eastman film four general processes may be considered: (1) chemical preparation of raw materials, such as the cotton and silver already mentioned; (2) spreading of the support or cellulose backing in thin layers on the surfaces of large coating wheels; (3) spreading of the sensitive emulsion in thin layers on the support, and (4) slitting of large film rolls into stock sizes, inspection and packing for shipment.

In addition to cleanliness, uniformly high quality is another important requisite in photographic materials; it means that a photographer can get the same kind of results at the one time with one piece of film that he can with another piece from different stock at another time, providing that in both cases the conditions of exposure and development are the same. Moreover, to maintain a high average quality film in the large quantities necessary for present day production requires the greatest care in the selection of raw materials and repeated tests, examinations and rejections. Then again, the manufacture of a product in large batches is far different from that in small lots; it requires a complete, smoothly working organization—team work.

The campaign for an absolutely pure product commences with the treatment and selection of raw materials, and is particularly rigid in connection with cotton. After being carefully cleansed and prepared to make it soluble, the cotton is passed through a huge drying machine in order to remove the moisture which it contains under ordinary atmospheric conditions. Special machines, called nitrating centrifugals, are used to mix the cotton with nitrating acids. A nitrating machine is shown in Fig. 2, with cover raised, and consists of a large-sized perforated basket which rotates in a vat. A mixture of nitric and sulphuric acid is poured into the vat until the cotton is completely immersed. Operators, protected by goggles and rubber gloves, douse the cotton with paddles, as shown. The sulphuric acid is used to dilute the nitric acid and to absorb any moisture present in the mixture.

Fig. 2. Nitrating Centrifugal.

After a short immersion the acid is drained off from the cotton and then the basket is rotated at a high speed to throw out through the perforations as much of the acid as possible. The treated cotton is next removed to tanks of water, where it gets its

first washing. After being rinsed it is again passed into centrifugals, where water is played on it, and then conveyed to other tanks where it is thoroughly washed to remove all traces of acid. The excess of water is now removed and the cotton is then ready to be taken into solution by organic solvents. When it is dissolved a solution is formed very similar in appearance to honey. This, in Kodak parlance, is called "dope."

The dope is passed through a system of filters and finally spread in thin layers on huge drums, which form parts of machines each of which weighs approximately 150 tons. When dried it becomes the familiar transparent support on which the sensitive material is coated. In spite of the mammoth size of the machines, the accuracy is such that in a roll of film as it comes from the machine, 3½ feet wide and 2,000 feet long, the variation in thickness is not more than one-quarter of a thousandth of an inch from end to end. Several thicknesses of support are made, varying from the thin support used in Kodak film to the heavier type used in Dupli-Tized films.

The silver which is used to make the sensitive emulsion is the purest that can be obtained and comes in bars, each weighing about 500 Troy ounces. These are dissolved in nitric acid under correct chemical conditions, forming silver nitrate in solution, which in the next step is evaporated to crystallization. The silver nitrate crystals are next redissolved and recrystallized until all impurities are removed, a process which virtually reduces itself into a chase after that one-tenth of one per cent of foreign matter in the bullion silver. The final pure white crystals are next placed in shallow glass trays and allowed to dry under carefully controlled conditions. They are finally placed in covered jars and stored until needed.

Three stages in this process are shown in Fig. 3 (A-B-C).

III. The Emulsion

The most interesting step in the manufacture of either plates or films is in the making of the sensitive emulsion. In preparing this a solution of silver nitrate is mixed with a solution of potassium bromide and gelatine dissolved in hot water. In the reaction of potassium bromide and silver nitrate the silver unites with the bromine to form silver bromide, the potassium taking the place of the silver to form potassium nitrate. The silver bromide, being insoluble in water, is left suspended in the gelatine, while the soluble potassium nitrate is subsequently removed by washing. In Fig. 4 is shown a greatly enlarged section of undeveloped silver bromide crystals in gelatine, while in Fig. 5 is shown a section of developed emulsion showing the reduced metallic silver clots.

This suspension of silver bromide in gelatine is coated on film support or plates while still in the form of a thick liquid. Special machines have been evolved for correctly performing this operation, for it is essential that this coating of silver bromide and gelatine be put on the support at an absolutely uniform rate and that this jelly should be set rapidly by sudden chilling.

To perform this process on a commercial scale, in which thousands of square feet of support must be coated daily, requires great care and vigilance in order to produce a uniformly high quality product. In the case of films, they are coated in great rolls about forty inches wide, which must be dried before they can be re-rolled and handled. In the making of Dupli-Tized films, the first coating must be put on, dried, and the entire length rolled up before the second coating can be put on the reverse side. After these large rolls of film are dried they must be kept under uniform conditions of temperature and humidity until they are sent out to the consumer, whether they are Dupli-Tized films, dental films, motion picture films or Kodak films, and the package in each case must be designed with a view toward having them reach the consumer in the same condition as when they are made.

In the manufacture of Seed *X*-Ray Plates the same general type of emulsion is used as for Dupli-Tized films; that is, it is specially

FIG. 3-A. SILVER INGOTS.

FIG. 3-C. SILVER NITRATE CRYSTALS.

FIG. 3-B. SILVER NITRATING ROOM.

prepared with a view toward having it as sensitive to *x*-rays as possible, its sensitiveness to ordinary light being of no special importance. The glass must be carefully washed and put in proper condition for being coated with the sensitive emulsion. After coating, the drying is conducted under conditions similar to those used for drying films. There must be a constant drying rate, otherwise a mark will show in the final negative, and it is needless to say that there must at all times be absolute freedom from contamination in the air in the coating, drying and storage rooms.

This condition, of course, also holds good in the case of either films or plates for their entire life history. Temperatures over 70° F. should be avoided where possible, as well as excessive humidity. These two are the greatest foes to emulsion keeping.

When one considers, however, the vast strides made in photographic science since the days of the old wet plate—only a few score years ago—by concerted scientific efforts, one cannot but feel that, with the even greater efforts now applied, stimulated by its war prominence as a science, photography in general, and roentgenological photography in particular, will give rise to many new possibilities.

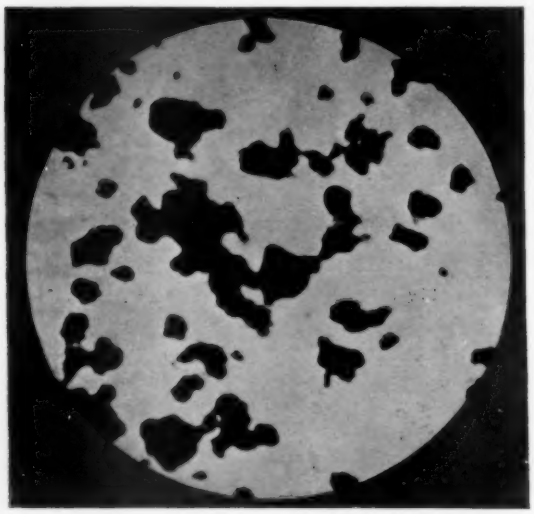

FIG. 4. SILVER BROMIDE CRYSTALS IN EMULSION.

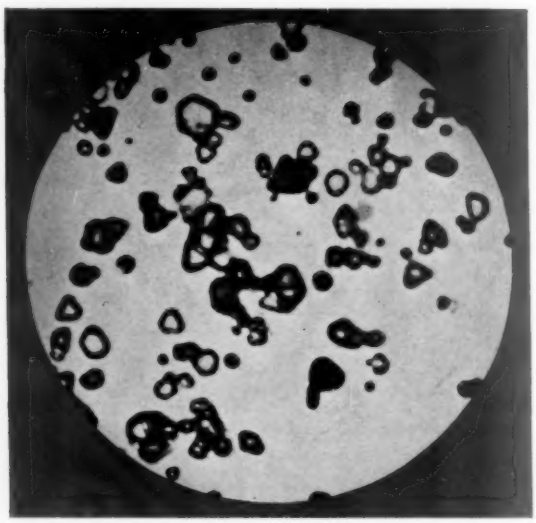

FIG. 5. CRYSTALS SHOWN IN FIG. 4 DEVELOPED TO METALLIC SILVER.

FLUOROSCOPIC EXAMINATION IN INJURIES TO THE HEAD

By M. WILLIAM CLIFT, M.D.

Late Major, M. C., U. S. A.,; Instructor in Roentgenology, A. E. F.

FLINT, MICH.

THE head, including the accessory sinuses and jaw, has usually been considered as a field quite outside the scope of fluoroscopic technique. The enormous experience of the war has served, however, to demonstrate very clearly the usefulness of fluoroscopy in these cases. Not only intracranial foreign bodies, but small fractures, empyemata of the sinuses and minute foreign bodies in the orbit are easily demonstrated with the fluoroscope.

The author's excuse for considering this subject at such a late day is that experience has shown a distinct application of these essential military procedures to the work of civil roentgenology. It may be well to state clearly at the outset that the intention is not to urge the substitution of fluoroscopy in the examination of head cases for the ordinary procedure of stereoscopic plating. The use of stereoscopic plates in the examination of head injuries and intracranial conditions will always be the most important. However, the author is firmly convinced that preliminary fluoroscopy will generally facilitate the examination and increase its accuracy. Furthermore, the standard positions used for roentgenography of the head do not always show the lesion, particularly a depressed fracture, to the best advantage; but, with preliminary fluoroscopy, it is possible to place the head in such a position as to give the best projection on the roentgen plate.

The small radiator type Coolidge tube, because of its fine focus, produces a very clear and cleancut image which is essential in examining the head, and, together with the army table, makes an ideal apparatus for this work.

TECHNIQUE

The proper preparation of the retina prior to beginning the examination is of prime importance here, as in other parts of the body. Under the exigencies of military practice it was often impossible properly to protect the hands while examining the head fluoroscopically. This was but one of the conditions in which the roentgenologist of necessity was required to consider the patient rather than himself. However, under the conditions obtaining in ordinary civil work, there is no necessity to bring any part of the hand within reach of the active rays. It is quite possible to place the head in the position described below, turning the current on only after the hand has been removed. In making the examination of the sinuses as described in the body of this paper, the patient's head can be supported upon an air pillow, thus avoiding the placing of the hand in the path of the rays. We, therefore, feel that the question of safety to the roentgenologist, at least, is not a factor to be considered. As to the question of the exposure to the patient, it may be said that when following the routine as laid down the skull is completely gone over during a very short examination. There is no advantage in prolonging the exposure by continued observation of single areas. As one becomes experienced in fluoroscopy of the head and fluoroscopic anatomy, all that can be determined will be during a comparatively short observation. However, the total radiation given must come within the limits of safety and the danger of too prolonged an examination kept constantly in mind.

Thoroughly to explore the part and avoid the chance of missing important pathology, it is desirable to have a routine method of procedure. The following technique has recommended itself because it is both rapid and accurate. The tube is adjusted to a five-inch gap with a current of from three to five ma.

CRANIUM.—The patient is placed in the

dorsal position on the trochoscope. The head, with the face turned up, is grasped in the observer's right hand and rotated slowly from left to right 90 degrees. While rotating, the outline of the skull is carefully studied with a small diaphragm opening for the presence of fractures. When the head has reached the lateral position, the diaphragm is opened, and a general survey is made of the cranium as a whole. It may often be desirable to obtain a true lateral projection, as a foreign body is often so situated as to make it difficult to determine whether it lies in the orbital cavity or anterior fossa. This can readily be accomplished by shifting the tube until the horizontal plate of the frontal bone casts but a single shadow. The head, which has been examined in the lateral position, is now rotated back again through an arc of 180 degrees until it lies in a lateral position, a reversal of the former, and finally back to the original position with the face anterior. Thus, it will be seen, the cranium has been covered twice in the examination with a conseqeunt reduction of the chance of error.

FIG. 1. PATIENT'S HEAD IN FIRST POSITION FOR FLUOROSCOPY. From this position the head is rotated to the right lateral and then to the left lateral position.

FIG. 2. POSITION FOR THE EXAMINATION OF THE ACCESSORY SINUSES AND OCCIPITAL REGION (Waters and Waldron).

ACCESSORY SINUSES.—Having completed the general survey, the frontal sinuses and anterior ethmoids are examined in the anterior-posterior position. The operator's right hand is now placed beneath the occiput and the patient's head raised until the shadow of the greater wings of the sphenoid no longer obstructs the view of the antrum. The patient is then placed in the ventral prone position and the head held so as to conform to the position described by Dr. Waters. This gives essentially the same projection as the radiographic method, although the relative position of the tube and head are reversed.

Fluid (pus or blood) or foreign bodies in the antrum or sinuses are easily determined.

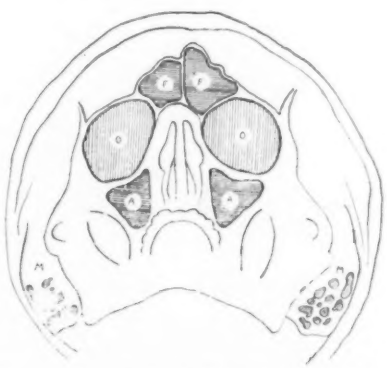

FIG. 2A. DIAGRAM OF FLUOROSCOPIC IMAGE OBTAINED BY THE POSITION ILLUSTRATED IN FIG. 2. *F*—Frontal Sinus, *O*—Orbit, *A*—Antrum, *M*—Mastoid.

Occasionally the overlapping of the shadows of the opposite sides gives the appearance of a foreign body. However, if the head is rotated the density of the suspected shadow

will diminish at some point during the rotation. On the other hand, a foreign body will always show the same density without relation to the position from which it is viewed. If within the sinus, the shadow of the foreign body will always show within its outlines notwithstanding the position of the head.

FIG. 3. ANTERIOR-POSTERIOR POSITION FOR EXAMINATION OF THE ACCESSORY SINUSES AND FRONTAL REGION.

FIG. 4. POSITION FOR THE EXAMINATION OF THE MANDIBLE. Slight variations in the angle permit a very satisfactory view of the mandibular articulation.

JAW.—With the patient lying in the dorsal prone position, the head is slowly raised until the outline of one ramus shows unobstructed. Shifting the tube also assists in displacing the two sides of the jaw.

FIG. 5. HEAD PARTIALLY ROTATED TO RIGHT.

EYE.—In searching for foreign bodies in the orbit, the head is turned so that the injured eye is nearest the screen. It is then rotated until a silhouette of the lids is obtained. In this position, the cornea can occasionally be seen and any foreign body located in reference to it. The patient is directed to look up and then down when the shadow of the foreign body will move with it, if it is intra-ocular. A foreign body located in the extrinsic muscles may also show the synchronous movement, in which case it will be difficult to establish its location definitely. However, examination in the anterior-posterior position will often clear up the situation. Throughout the examination the smallest diaphragm opening consistent with a proper view of the area should be used.

FIG. 4A. DIAGRAM OF FLUOROSCOPIC IMAGE OBTAINED BY THE POSITION ILLUSTRATED IN FIG. 4. *A*—Antrum, *M*—Mastoid, *X*—Mandible.

FOREIGN BODIES.—The usual procedure for the localization of foreign bodies else-

where in the body becomes inadequate for the requirements of surgery of the head and brain. In this field the surgeon is interested in obtaining data covering the following points:

1. Is the skull penetrated? If so, the extent and nature of the fracture.

2. Is there dural penetration as evidenced by bone fragments or foreign body?

FIG. 6. EXTENSIVE FRACTURE OF SKULL DUE TO HIGH EXPLOSIVE SHELL. This illustrates the advantage of fluoroscopy in selecting the best position to show the extent and character of the fracture.

3. Is there a foreign body present? If so, what is its (a) size, (b) location in reference to the tract and anatomical structures, (c) depth? The actual mathematical depth of the foreign body is placed last in the list, as its importance is far less than an accurate knowledge of the anatomical relationship. The reason for this statement requires no discussion in view of the following statistics of Cushing covering the mortality in head injuries:

MORTALITY IN HEAD INJURIES

Fracture of the skull without penetration of the dura	30 per cent
Penetration of the dura by bone fragments or other foreign bodies but without involvement of the ventricles	50 per cent
Penetration of lateral ventricles . . .	100 per cent

The above statistics, quoted from memory, are substantially correct.

To obtain the best results, the roentgenologist must establish a close liaison with the surgeon and must adapt his methods of procedure to the subsequent surgical requirements. In cases of recent injuries the surgeon will prefer to work from the wound of entrance; accordingly, the localization should be made in reference to the site of the injury.

Experience has shown that the track of a foreign body in the brain pursues a fairly straight course. This is an important fact in determining the particular mode of procedure for localization. If then the head is rotated until the vertical ray passes through both the foreign body and the wound of entrance, the observer is practically looking down the track. With the depth ascertained by one of the various methods in common use (Strohl—26 degrees, or Roussell) the surgeon has a guide to the missile without need of skin marking.

Between the various methods for obtaining the depth of a foreign body there is little choice as far as accuracy is concerned. The writer, however, has a preference for the Roussell method. This differs from the Strohl method in the substitution of small notches in the slit diaphragm in place of the usual wires, the underlying principle being the same in both methods. The point of advantage lies in the fact that a foreign body is easily picked up and registered in the illuminated area of the diaphragm, whereas it is often difficult to make out the hazy outlines of the Strohl wires, particularly in the cranium.

One of the greatest needs has been an accurate method for determining the position of a foreign body in relation to important anatomical structures of the brain. The author has attempted to solve the problem by the use of a cross section anatomy with a key plate on celluloid, showing the lateral outline of the skull with the various sections of the anatomical plate indicated thereon. The key plate is used directly on the fluoroscopic screen, and with the depth of the foreign body acquired by the Strohl or some other method, the exact anatomical location can be quickly determined by consulting the

appropriate section of the cross section anatomy. The importance of such a method will probably be greater when applied to cases of foreign bodies remaining in the brain for long periods after their entrance. These cases will engage our attention from now on.

OPERATIVE GUIDES

Various devices have become available during the past five years to assist the surgeon in the removal of foreign bodies. In the strict sense, most of these methods are surgical rather than roentgenological. However, they represent such an important part in the work of the roentgenologist that it would appear that they should receive at least some comment in this paper. The intermittent control method of Ledoux-Lebard is of greater importance in cases of foreign bodies located in the face, jaw or neck than in the brain. Its greatest value is manifest in those cases in which the surgeon has found difficulty in extracting the foreign body, or in which its position is in the neighborhood of some important anatomical structure and it is desirable to remove the foreign body with the least possible traumatism.

With the Dessane bonnet fluoroscope the roentgenologist is able to guide the surgeon who works in a light operating room, in an expeditious removal of the foreign body. The sense of security which the fluoroscopic control inspires in the surgeon is by no means an unimportant consideration and constitutes one of its most important advantages.

Of the instrumental operative guides for the surgical removal of foreign bodies, the Hirtz compass is by far the most important. Considerable misconception seems to exist as to the indications and scope of this instrument. It must be emphasized that it is in no sense a localizing instrument but strictly a surgical guide comparable to the grooved director. The statements repeatedly made in text books and articles that the time necessary to apply the compass is prohibitive to its general use can only be explained by a lack of personal experience with the apparatus by these authors. The method of application as modified by Hirtz and Gallot, more than two years ago is so simple that it is adaptable for use in even the most advanced hospitals. With fluoroscopic technique it is possible to adjust the compass by means of the small spirit level in from three to five minutes. Certainly the time factor as here indicated cannot be considered as important when contrasted with the advantages in those cases which meet the indications for its use. Contrasted to one's impressions at first glance, however, the indications for the use of the Hirtz compass in brain surgery are rather limited. This is largely due to the fact that the surgeon is not so much in need of a guide, which in a measure is furnished by the tract itself, as a means of extracting the foreign body with minimum traumatism to the brain substance.

M. Henri Béclère has attempted to supply this need by the use of a small electromagnet in conjunction with the compass. The instrument is applied in the usual way. The obturator is, then passed through the trephine opening and plunged into the brain to the depth of the foreign body. The magnet is then attached to the obturator, which is slowly withdrawn, bringing the projectile with it. The method is very satisfactory, not to say spectacular, when applied to those cases in which the foreign body is magnetizable. Unfortunately, however, it is not applicable to those cases in which fragments of bone or non-magnetizable metallic bodies are the disturbing elements. Furthermore, it is impossible to foretell conditions in this regard prior to the actual application of the instrument.

However, it is possible to adapt a simple forceps similar to that used in the bronchoscope to the Hirtz compass, which will meet all the requirements. These forceps will take the place of the central rod or obturator supplied with the instrument, serving as a means for grasping and removing the foreign body.

The compass possesses the important ad-

vantage of offering a firm support for the forceps which can be passed down the tract of the missile with a minimum amount of traumatism to the uninjured tissues. This is more important when dealing with brain injuries than in any other type of work.

In conclusion it may be well to state what might possibly have served more properly as an introduction to this paper, namely, that the foregoing discussion simply represents the outline of the writer's notes made in France at an advanced hospital devoted to the care of head and brain injuries. No attempt has been made to cover the subject in detail, but rather to present a general survey with the hope that it will serve to stimulate an interest in fluoroscopy of the head which, we believe, has a very definite advantage.

A SATISFACTORY INJECTION MEDIUM FOR THE RADIOGRAPH OF FISTULAE

By NEIL MacLEOD, M.D.

[Abstract from the *Archives of Radiology and Electrotherapy*, London, November, 1919.]

The purpose of these injections is two-fold: (1) To obtain a true estimate of their relations to bones and their extent, including those of branches and abscesses communicated with; (2) To detect the presence and nature of foreign bodies if they are preventing closure.

The emulsion used consists of oxychloride of bismuth 1 part, and mucilage of acacia 2 parts, both materials and proportions chosen as being the best for showing the fistulous tract and abscess cavities.

The mucilage of acacia with the bismuth in suspension, when injected, apparently mixes with their purulent contents, furnishes a comparatively transparent shadow which discloses the extent of the abscess cavity and the fistulous tract, both in relation to the bones and also the relations of an empyema cavity in relation to the lungs and chest wall. It is of especial value when seen in stereo projection.

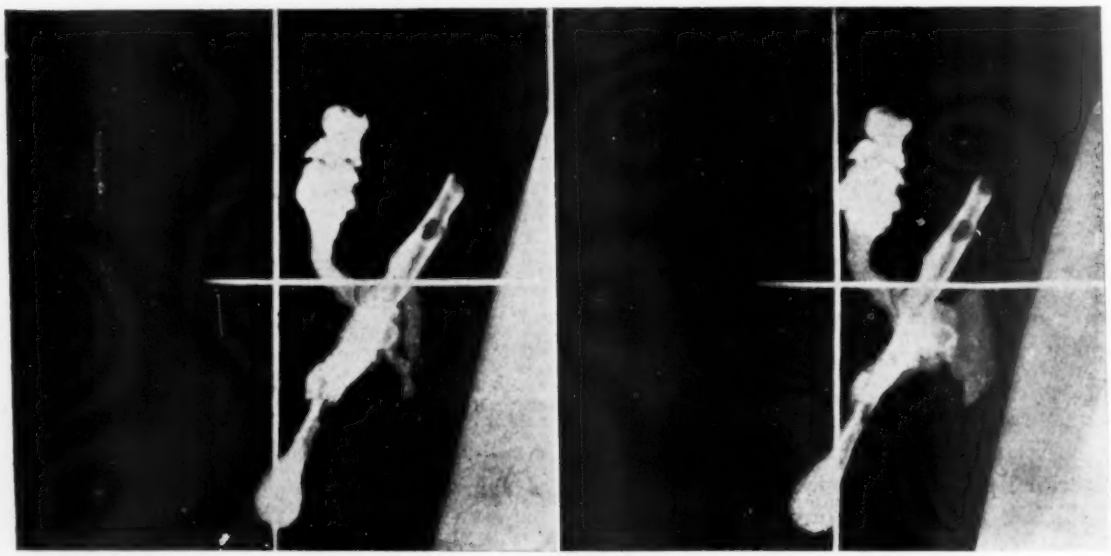

FIG. 1. Shows the result in a branching sinus containing what could be recognized as the reed. With the stereoscope the reed is seen to be foreshortened, making an angle with the plate of about 45 degrees. A bubble of air can be made out near its upper end, probably injected with emulsion. The blunt-ended shadows at the bottom and top are *cul de sacs*, the fluffy shadow on the right of the reed leading to the opening in the skin plugged with cotton wool.

WEBSTER W. BELDEN.

DIAPHRAGMATIC HERNIA

By ALEXANDER STEWART MACMILLAN, M.D.

Formerly Lieutenant, M. C., U. S. A. Chief of *X*-Ray Service, U. S. General Hospital No. 1

NEW YORK CITY

AMONG approximately 15,000 cases examined in the *x*-ray laboratory at General Hospital No. 1, three cases of diaphragmatic hernia were found. It is of interest that the diagnosis in each case was first made by roentgenographic examination.

CASE I. Lt. S. Age twenty-three. While in action he received a hand-grenade wound in the left chest which fractured three lower ribs. He was taken prisoner. No operation was performed, as the injury was considered superficial. On release to an American Hospital a radiograph of the chest, which was taken to determine the extent of injury, revealed a diaphragmatic hernia. The only symptoms complained of were slight dyspnea on exertion and occasional eructation of gas. On return to this side, a fluoroscopic examination showed the meal to pass down the esophagus to below the level of the diaphragm and back into the thoracic cavity, where it emptied into the fundus of the stomach. The stomach, once full, emptied readily through the duodenum. Bismuth enema showed the splenic flexure also in the thoracic cavity. Fig. 1 shows the heart displaced to the right, and the stomach in the left chest to the level of the third rib anteriorly. The haustral markings and gas in the splenic flexure (Fig. 2) are seen to the left of the stomach, the gas bubble in the stomach being between the heart and the splenic flexure. Apparently the opening in the diaphragm was large enough to cause no embarrassment in the emptying of stomach or bowel. This patient was discharged with major disability. A month later word was received at the hospital that the patient had been operated on and died the following day. Neither the cause for the operation nor the cause of death were stated.

FIG. 1. CASE I.

FIG. 2. CASE I.

CASE II. R. W. Age thirty-one. While in action, September, 1918, patient received an injury in the left chest by shell fragment which fractured the 6th and 7th ribs posteriorly and penetrated the lung. Empyema developed following this injury. The pleural

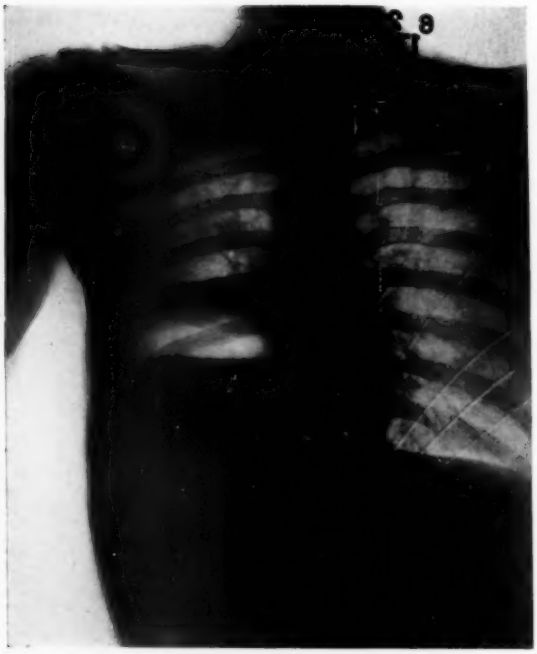

FIG. 3. CASE II.

cavity was drained, and by March, 1919, all wounds were healed. In May, 1919, while on sick leave in New York City, the patient was taken suddenly ill. The onset was characterized by severe vomiting, soon followed by a sharp pain under the left costal margin with general crampy pains throughout the abdomen. Nausea continued, but the patient was not able to bring up anything after the first attack of vomiting. The patient was hungry but unable to eat, as the taking of any kind of food caused severe pain in the upper left quadrant. At no time were the symptoms referable to heart or lungs. At the end of a week, as the symptoms had not subsided, the patient was removed to General Hospital No. 1. Physical examination showed a soft but retracted abdomen. Percussion of the left lower chest showed normal lung resonance above, tympany from sixth to eighth ribs posteriorly and flatness at the base. These findings could have been accounted for by a pyopneumothorax. The correct diagnosis was made by roentgenographic examination. Fig. 3 shows the stomach full of fluid in the left chest reaching as high as the level of the fourth rib anteriorly. A stomach tube was passed and 1,000 c.c. of foul, dark colored fluid removed. Laboratory reported no free or occult blood, no free or combined HCl, no colon bacilli or bile. The following day a

FIG. 4. CASE II.

FIG. 5. CASE II.

barium meal was given and radiograph (Fig. 4) taken which showed the meal to pass down the esophagus into the abdomen and back through the diaphragm into the stomach, none entering the small intestine. A twenty-four hour radiograph showed almost complete gastric retention. (Fig. 5.) The portion of the meal that had been retained in the esophagus had been vomited. A diagnosis was made of strangulated hernia of the stomach through the left diaphragm. Operation showed the stomach to be the only abdominal organ above the diaphragm, and that it had entered the thoracic cavity through a small opening in the posterior portion 4 cm. from the esophageal opening. The stomach, in good condition, as far as could be seen, was freed from adhesions and returned to the abdominal cavity. Gangrene set in and the patient died ten days later.

The cause of the hole in the diaphragm in this case could have been due to tearing of adhesions or to injury by shell fragment. No evidence had been seen of a hernia at the other hospitals where this man had been a patient. The probability was that the severe vomiting forced the stomach through a small existing hole in the diaphragm which resulted in strangulation.

Case III. C. W. Age thirty-one. In March, 1919, while in France, the patient had a lobar pneumonia in the left lower lobe. Empyema followed and was drained for two months, after which healing occurred. The patient arrived on this side in June, when a radiograph (Fig. 6) was taken to determine the lung condition before discharge. It showed the stomach fluid level and gas bubble in the left chest up to the level of the fourth rib anteriorly. The barium meal showed an hour-glass stomach, the fundus being above the diaphragm and the pyloric end below. The constriction was due to the relatively small size of the diaphragmatic opening in comparison to the size of the stomach. The stomach was empty at the end of two hours. A barium enema showed the splenic flexure also in the thoracic cavity (Fig. 7).

Fig. 6. Case III.

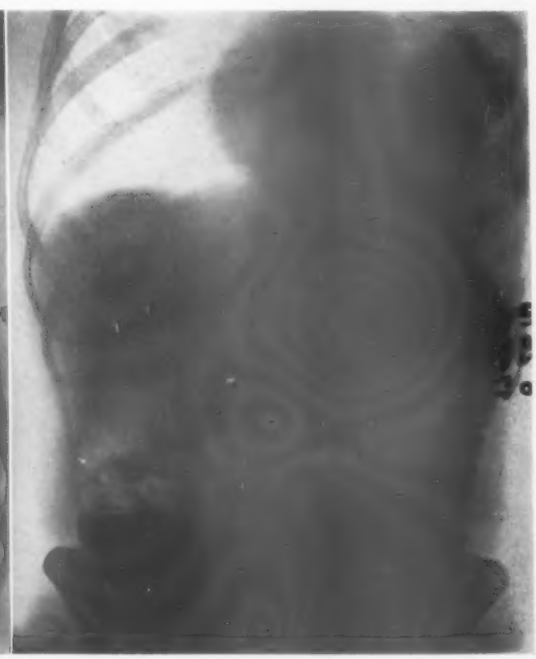

Fig. 7. Case III.

The patient's only complaint was slight dyspnea. There was no pain in the left side

or constipation. Neither the stomach nor the large intestines showed any embarrassment by the diaphragmatic constriction. The etiology in this case could not have been shell injury, as the patient did not see action. It was either congenital or due to operation, the latter cause the more probable.

None of the three patients complained of symptoms of pulmonary or cardiac embarrassment. Digestive disturbance was noted only in the case with strangulation. In one case the stomach was the only abdominal viscus in the chest, while in the other two cases the splenic flexure also went into the thoracic cavity. The spleen and kidneys did not enter the chest in any of the three cases. The diagnosis was made in each case by radiograph. At first glance in the fluoroscope the appearance was similar to an undrained empyema except for the dome shaped gas bubble above the horizontal fluid level of the stomach with the patient in the erect position.

THE ROENTGEN RAY IN CANCER OF THE UTERUS*

By HENRY K. PANCOAST, M.D.

PHILADELPHIA, PA.

IN the treatment of any malignant condition by roentgen rays or radium or by both agents, one must carefully consider the primary growth, the avenues by which metastasis takes place, and the locations in which metastatic proliferation of cells is likely to occur. Unless all three of these danger zones are known, carefully considered, and vigorously treated, no method of treatment can be ultimately successful, except when the primary growth is discovered and attacked early, before metastasis has taken place, and all malignant cells can be removed or destroyed. In the case of the uterus this is unusual rather than the rule. One must also consider the possibility of stirring up metastasis by vigorous measures directed against the primary growth. The more advanced it is and the nearer it is to the border line of being inoperable, the more likely are cells to be disseminated through lymphatic channels to start up metastases. If the primary growth cannot be removed entirely by excision and probably by radium and other methods as well, it is likely to recur rapidly and grow and metastasize quickly.

Roentgen ray treatment alone cannot be regarded as a strictly rational measure in dealing with uterine carcinoma. Its purpose is as a supplementary procedure to follow operation or the use of radium, and it cannot, therefore, be discussed without alluding somewhat to these other measures. It can be employed as a postoperative procedure, but we believe that it is more likely to prove efficacious when employed in conjunction with radium.

Our deductions in regard to the efficacy of roentgen ray treatment following the application of radium are based upon the assumption that the use of the latter is the method of choice in those cases starting in the cervix in which the growth, however, is not distinctly limited to the cervix, but has invaded beyond. In such cases no one can be certain that invasion through lymph channels has not taken place.

It is a well recognized fact that if the growth has invaded the broad ligaments and metastasis has already taken place in the pelvic lymph nodes, radium alone cannot cure the case, usually does little more than give temporary relief from the distressing local manifestations of the disease, and may not be able to relieve the pain, especially that which is produced by nerve pressure from secondary lesions. It has frequently been stated by those who do not fully understand the action of radium, that cases become

*Read at the Clinical Congress of Surgeons, New York City, October, 1919.

worse after its use, even when it has been judiciously employed, and there may be some truth in such beliefs in many instances.

The dose of radium usually administered is the maximum one that can be given with safety and due regard for the integrity of important nearby structures. It is a well-known fact that the destructive effect of such a dose is not exerted beyond a certain definite area of a few centimeters' diameter, whereas, to be effectual, all cancer cells must be destroyed. Beyond this area the application can do no good. Although there is still considerable dissension over the question, there seems good ground for believing that too small a dose of radium, or one insufficient to inhibit cell growth, may aggravate cell proliferation. This fact should, however, not prevent its employment in cases in which the growth extends beyond the limits of possible cancer cell destruction, but it does call for any help that can be given to augment the action of the radium at the periphery of such a growth. We believe that in the roentgen ray we have a means of accomplishing this in some instances. The principle is at least sound in theory, and if not in practice, that has as yet not been definitely proven by statistics. The exact extent of benefit to be derived in this way will be difficult to determine and will require very careful statistical study.

Unless such roentgen ray treatment is systematically and judiciously carried out on the basis of a thorough knowledge of the anatomical structures involved or likely to be involved, it is a waste of time, and moreover, careless and unscientific treatment is likely to cause stimulation of cell proliferation just as is radium. In planning the procedure in each case one must consider the primary growth and its extent, the paths of metastasis and the location of lymph nodes likely to be involved. All these points must receive a destructive dose, or one that is likely to be destructive when administered as supplementary to the dose of the radium application. This is a task of prodigious proportions.

In an individual of ordinary build a maximum dose of deeply penetrating and carefully filtered roentgen rays must be introduced through seven to ten ports of entry at the skin surface in order to be in any way destructive to cancer cells in the pelvis within an area of the same or nearly the same size. When we consider the total area of possible involvement by the growth and its metastases, the number of ports of entry must be multiplied many times. Certainly thirty to fifty are none too many, distributed anteriorly and posteriorly and from every other possible direction. In stout individuals more may be required, but fortunately they possess more skin surface. Such extensive and intensive treatment is bound to exert some effect upon the intestinal tract, and may even do some harm in a very few instances; but this is not to be considered in comparison with the harm to arise from the growth.

The use of radium needles and emanation tubes around the periphery in addition to the introduction of radium into the cervix and over the central portion of the growth, is probably yielding as good results as will ever be obtained from radium. Statistics have been improving up to this time. Personally we have no statistics to offer in support of the supplementary use of roentgen rays, and the only proof of added value will have to be determined in this way from a large number of cases so treated and compared with the results following radium alone. It seems worthy of trial, but the roentgen treatment must be carried out with as uniform and accurate technic as has been employed in connection with radium.

INFLUENZA PNEUMONIA FROM A CLINICAL AND X-RAY STUDY*

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II. Influenza Pneumonia

IN the review of the pulmonary involvements which followed or were associated with influenza, 260 cases were analyzed for this paper, of which 190 had been studied by daily serial *x*-rays, the standard U. S. A. bedside *x*-ray machine being employed for this purpose. A number of these cases were studied from the very day on which they entered the hospital as influenzas, when physical signs in the lungs were as yet nonexistent, others from the very moment of the first indication of pulmonary involvement. The method employed caused the patient very little, if any, discomfort. In our observations we soon learned that the predominating type of pneumonia we were dealing with behaved in an altogether distinct fashion, both from a clinical and roentgenological point of view. The intrathoracic complications which presented themselves from an *x*-ray standpoint were the following:

(1) Hemorrhagic pneumonitis involving various lobes
(2) Interlobar pleuritis
(3) Adenitis, mediastinal and peribronchial
(4) Cardiac enlargement
(5) Empyema
(6) Pericardial effusion
(7) Lobar pneumonia
(8) Diffuse mottling (so-called streptococcic pneumonia)
(9) Plastic exudate
(10) Mediastinal empyema

From a clinical study, of course, it was impossible to detect absolutely certain of these conditions, because of limitation in our methods of physical diagnosis. Thus, for example, interlobar pleuritis so frequently observed by the *x*-ray as a fine hair line of density between the lobes, never was detected by physical signs alone until an effusion took place.

Clinically, two classes of cases were encountered. First, those that ran a regular course of influenza, and then developed signs of pneumonia. Second, those in which there was a gradual onset of the pneumonia as a rule of two days' duration, characterized by general malaise, headache, beginning fever, pain in chest and cough.

In the large number of patients in whom pneumonia was a complication of influenza, this striking fact was noted. On about the third or fourth day, the temperature would drop and remain normal for one or two days. Then, without any warning, would occur a secondary rise of fever which within twelve hours reached 103° or 104°. The patient who had been feeling well for the past two days would again be prostrated.

In mild cases of either of the two types mentioned above, presenting a unilateral lesion, the temperature ranged from 100° to 103°. The pulse was characteristically slow. It was low in tension, systolic, varying between 110 and 120 and diastolic between 65 and 75. Respirations were not exaggerated, and usually 26. The average duration of temperature in such cases was five and seven-tenths days.

It was in most instances of a continuous type, with daily variations of 1 to 2 degrees. It terminated by crisis in 80 per cent; by prolonged crisis or lysis in 20 per cent.

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Those with bilateral lesions were more severe, and the above phenomena much more exaggerated. The cyanosis which has been dwelt on as present in the very sick influenzas became a constant and familiar feature. The color varied from a marked erythemia to an almost indigo blue, especially in those whose lobes were extensively affected. Conjunctivae, mucous membranes, especially the gums, had a deep purplish tinge. The tongue was coated, the pharynx congested. Herpes were not infrequently observed. The patient often had a haunted, anxious expression. Sweating was as marked as in the uncomplicated acute influenzas. The temperature ranged between 101°and 105°. It was, in most instances, continuous in character, at times intermittent, with daily variations of two to three degrees. In certain cases one could anticipate the progress of the pulmonary involvement by the waxing and waning of the temperature curve. Thus, it would be continuous for two or three days, come down to normal, and go up again for three or four days with a fresh extension of pneumonia, finally to come down. The average duration of temperature in such cases was eight and four-tenths days. The defervescence in these bilateral pneumonias was also by crisis in 82 per cent, by prolonged crisis or lysis in the rest. The pulse here likewise was markedly slow, the lowest 85, the highest 140, average 115. Frequently, dicrotism was noted. Respiration varied between 25 and 35. Cough was frequent. Expectoration was blood-streaked or muco-purulent in nature.

Very severe types, and those which went on to a fatal termination, were toxic from the beginning. Delirium came on early and persisted until the end. Coma vigil was not infrequently observed. Dyspnea, in which all the accessory muscles of respiration were employed, was pronounced. Respirations varied between 30 and 75.

The majority were either cyanosed or had a muddy clay-like pallor. These last were more asthenic than the others. The pulmonary spread was rapid; beginning usually on the left, it quickly went on to the right and up the left, or right, until the entire lung was filled with areas of bronchial breathing associated often with moist crepitant and sub-crepitant râles, anteriorly and posteriorly. With the rapid onset of pulmonary edema everything was obscured by the stridor and bubbling râles. The temperature in such instances would be about 105°, continuously rising, and death would ensue in three or four days with fever between 107° and 108°.

The pulse presented all the characteristics of a failing myocardium. It was rapid, thready and scarcely perceptible. The heart in some instances was enlarged on the right, but most often it was impossible to detect this.

The clinical complications which those cases presented were as follows:

Nasal.—Epistaxis was present in 10 per cent of the cases; acute rhinitis in 3 per cent.

Mouth.—Gingivitis was seen in two cases. Tonsilitis was a rare complication; pharyngitis and laryngitis in 5 per cent, and ulcerative laryngitis was observed in two cases. In one, the ulcerations on vocal cords were due to a secondary hemolytic streptococcic infection. These entirely disappeared within two months.

Ears.—Otitis media, catarrhal and suppurative, and sinusitis also prevailed but in a very small percentage of cases. (This has already been discussed under "Influenza.")

Eyes.—Conjunctivitis, simple, was often evident. One case was due to the Morax-Axenfeld bacillus.

Chest.—Pleurisy with effusion, both serous and bloody, was frequently noted. Empyema, especially in the later cases, occurred eleven times; mediastinal empyema in one instance. This does not include cases that went on to a fatal issue.

Pericarditis.—Occurred more often during December, January and February. Both serous and purulent types obtained.

Heart.—Valvulitis was observed in three instances, the mitral being diseased in each case. Toxic myocarditis with various types of extra systoles and tachycardia as sequellae were present in 10 per cent of cases.

This condition cleared up in two to three months.

Gastrointestinal.—Occasional diarrhea was present. Abdominal distention with tympanitis associated with toxemia was repeatedly seen at the height of the fever.

Urinary Symptoms.—Analysis of 2000 urines showed a toxic nephritis in almost every instance. This varied from a mild albuminuria associated with few granular and hyaline casts which rapidly cleared up as the patient got well, to heavy traces of albumin and showers of all sorts of casts. Cases which presented the last terminated fatally. The blood urea and non-protein nitrogen in such instances was frequently increased. Acidosis [3] was also noted occasionally.

Skin.—Jaundice occurrd in 2 per cent of the cases.

Nervous Symptoms.—Delirium, tremors, toxic psychoses and meningism obtained in the very sick.

Blood Count.—The leukopenia, as was described, prevailing in straightforward cases of influenza, was likewise a constant feature in our pneumonia patients. The total white count ran between 2,000 and 10,000. The differential presented characteristics similar to the above cases, namely, a normal or diminished polynuclear count, with a relative lymphocytosis.

Leukocytosis up to 20,000 or 30,000 was seen in preagonal stages, when a pleuritis or pericardial involvement occurred, and occasionally with an extension of the process into other lobes. This, however, was not at all common, for frequently even to the very end the leukopenia persisted.

Physical signs associated with x-ray studies.—In comparing the physical signs which we found in the above cases with the *x*-ray films, certain illuminating facts come to our attention. For the sake of clarity we have divided the cases into three groups: (a) mild unilateral, confined to one lobe; (b) mild bilateral, confined to two or more lobes, and (c) more severe cases.

[3] The Van Slyke method was used in this determination.

(a) *Unilateral Cases.*—In the one lobe involvements, the physical signs would most often appear first at the lower angle of the scapula and gradually spread in a downward direction, towards the base of the lung. Where the process was mild, it would be characterized by fine and medium sized moist crepitating râles best heard at the end of deep inspiration over an area not more than 1 or 2 inches in diameter between the vertebral column and the angle of the scapula. These were accompanied by harsh breathing, suggestive of a broncho-vesicular type with practically no impairment of resonance on percussion, and no change in palpatory fremitus. Inspection presented no retractions and no immobility of the thorax. Some of these patients complained of pain in the chest, but the majority had no thoracic discomfort.

On the other hand, in the more severe unilateral cases, the crepitating râles which were early heard at the angle of the scapula, rapidly extended until practically the entire lobe was included. Within a few hours, the physical signs were completely changed. From a condition where the day before one heard a pell-mell of crepitating and subcrepitating râles, a massive consolidation succeeded. Dullness and somewhat distant bronchial breathing and no râles except at the edge of the consolidated area prevailed. Presumably it was a classical lobar pneumonia, and yet it differed entirely from the condition which we know so well. Here we were dealing not with a hepatization but rather with a bloody solidification, as we subsequently learned from our autopsy protocols, which showed that the lung parenchyma had become inundated with blood. This gave the signs of consolidation.

Out of 66 unilateral cases in this series, 46 had left lower involvement. The area affected varied from the size of a half dollar until almost the entire lobe was embraced, rarely the complete lobe such as you see in lobar pneumonia. Forty-five of these were confirmed by *x*-ray examinations.

Of the 22 cases in which the clinician had diagnosed a right lower lobe involvement

alone, only 9 were confirmed by serial *x*-ray film. In the remaining 13, the *x*-ray films showed a small lesion situated in the central portion of the opposite lung, or else there was in existence a small area of involvement of the right middle or upper lobe close to the hilus, so small and so contiguous to the lower lobe lesions that it was difficult of clinical differentiation. When, however, the lesion was more extensive, the physical signs closely paralleled the *x*-ray diagnosis.

The question which next demanded attention in this group was how often it was possible to get an *x*-ray evidence of pulmonary invasion before the clinical signs could be detected. For this purpose the unilateral lobe lesions were concentrated upon, and most often the milder cases, because the more extensive involvements were naturally older and presented no diagnostic difficulties.

It was here observed that in 2 per cent of left lobe lesions, *x*-ray evidence of inflammatory changes was obtained from two to three days before the physical signs were obvious. To be sure, those patients were sick, and were admitted as uncomplicated influenzas, presenting all the characteristic symptoms of such; and yet they had involvement with no detectable signs until the lesion became quite superficial. That this must have been so was gathered from studying our daily *x*-ray films, which showed that the pneumonia began at the hilus of the lung.

On the other hand, in 1½ per cent of cases, practically no physical signs at all were ever obtained. At most one could detect harsh breathing, so-called puerile, frequently attributed to toxemia, but no definite râles. These formed an exceedingly interesting group. Serial plates would show an initial film which was negative, subsequently developing pneumonitis very often not exceeding the size of a half dollar, which would disappear within two to four days. Those patients were not unduly sick, and under ordinary circumstances would have been discharged as influenzas without pulmonary involvement.

Another important feature in connection with unilateral lesions is the fact that 2 per cent, who on admission or later presented nothing but a generalized bronchitis, bilateral, with the usual sonorous râles, often showed on a film the characteristic shadow of hemorrhagic pneumonia in the left lower lobe. This alone was not large in extent but was yet presumably sufficiently deep to be masked by the associated bronchitis of the larger tubes, and in ordinary examinations would have been entirely overlooked. In other instances it occurred in more than one lobe.

In other words, small patches of bronchopneumonia demonstrable by *x*-ray are entirely obscured by the general bronchitis which prevents their detection by the clinician.

(b) *Bilateral Lobe Involvement.*—Many of the unilateral lesions did not stop there. In studying the progressive development of physical signs in connection with the *x*-ray, it was noted that the spread of pneumonia was readily comparable to the growth of a mushroom in that it always commenced at the hilus, the lesion spreading out from the root as a pivot. Both the left and the right lower lobes might appear to have become involved simultaneously, or the lower portion of the left upper and left lower, or possibly the mesial portions of the right lower, middle and upper, in their contiguous vicinity. Thence it was propagated toward the periphery, and on the plate, the involvement looked like an advancing film of smoke. Various combinations prevailed. In analyzing the lobar distribution in the films in 189 cases, the following was observed:

Involvements found	*Clinically*	*X-ray*
Right and left lower lobes only	69	42
Lower left lobe only[4]	46	45
Left upper and left lower lobe alone	0	9
Right upper middle and lower	1	3
Left upper and lower, right lower	1	1
Right middle and lower, left upper and lower	2	2

[4]The reason for this remarkable concidence is that the analysis of 470 cases studied by *x*-ray showed that in 82% the pulmonitis began in the lower left lobe, and in 14% was confined to that lobe.

Involvements found	*Clinically*	*X-ray*
Right middle and lower, left lower	4	3
Right middle and lower	4	8
Upper right, lower left[5]	1	1
Right upper, middle and lower	1	4
Right lower, left upper and left lower	1	1
All lobes	8	9

(c) *The severe cases* which recovered presented partial involvement of all lobes. There were 5 of those in which the affected areas were small, as may be readily understood, for otherwise when the involvement was extensive the mortality was high. It was an easy matter, both from a clinical and roentgenological study, to make a prognosis based upon the progress of a pneumonia. With the possible exception of one case, the roentgenologist from his point of view made a correct prognosis in every instance by watching the daily spread of the process. Frequently could be seen a recession of involvement one day, which almost always coincided with the clinical condition, and two days later a fresh spread, even over the same area, which was apparently recently subsiding, as corroborated by *x*-ray.

III. Sequellae and Complications

In those patients who recovered from Influenzal Pneumonia the following points were investigated.

1. How long did symptoms and physical signs persist after the *x*-ray became negative?

2. Did *x*-ray findings and clinical symptoms persist after all physical signs had disappeared?

3. Did physical signs and *x*-ray evidence of lung pathology disappear together?

(A) In analyzing 78 hemorrhagic pneumonias who recovered without complications, the following distribution was noted:

(a) Nineteen showed physical signs after the *x*-ray had become negative for pulmonary involvement.

(b) Forty-four presented *x*-ray signs after the physical signs had disappeared.

[5]In this case, the upper right was lobar pneumonia, the lower left, hemorrhagic pneumonitis.

(c) Fifteen became free from physical and *x*-ray signs about the same time.

The nineteen in whom physical signs were found to persist after the *x*-ray was reported negative for lung lesions, as a rule, were apparently well clinically. They complained perhaps of an occasional slight dyspnea on exertion and moderate cough as you might expect during convalescence. The temperature was down in all. The physical signs which they presented were either the sonorous râles of a generalized bronchitis or a few moist crepitations at one base or both. These were superficial and best heard on deep inspiration. The impression which this created was that the râles were due to atelectasis rather than actual infiltration. As a rule, no dullness was noted. The longest period during which these signs persisted was fifteen days, the shortest, one. No cardiac symptoms were noted.

The forty-four in the second group, who presented no physical signs but in whom there was a residual pneumonia as demonstrated by *x*-ray only, presented the following group of symptoms:

Asthenia was very marked. Loss of weight was pronounced. They coughed readily, occasionally expectorating blood-streaked sputum. Dyspnea prevailed on exertion. They were prone to have an occasional elevation of temperature up to 99° in the afternoon. Not infrequently, tachycardia was present. Convalescence was much prolonged. The longest duration in which *x*-ray findings persisted was twelve days; the shortest, one day.

In the third group, although the fifteen cases observed became free from clinical signs and *x*-ray evidence approximately at the same time, in some of them persistence of both continued three months and longer after the temperature was normal. Up to the present, in cases of this group who are still under observation, physical signs have been found for periods anywhere from three to fourteen weeks. They are usually basic in distribution, affecting most often the left lower lobe, and are characterized by crepitating râles, moist, fine and medium sized,

associated with broncho-vesicular breathing. Such cases bear a striking resemblance to the persistent hemolytic streptococcic pneumonias, which we saw frequently last year (1917-18). In those, physical signs remained for four to five months, and frequent search for the tubercle bacillus proved fruitless. When one bears in mind that secondary infection is of such importance in influenzal penumonias, where the pneumococcus and hemolytic streptococci are so frequently found, it is not at all surprising that we may have persistent pneumonia due to these secondary invaders. That such bacteria are not at all unlikely to produce a productive inflammatory lesion where the process goes on for some time, is well known. When frequent examinations of sputum by the mouse inoculation method reveals the presence of these organisms time and again, such assumptions are not at all unfounded. This has been demonstrated in our cases; *x*-ray in such instances often shows localized involvement, and in addition a high degree of peribronchial fibrosis (peribronchitis) and peribronchial adenitis.

It is not at all surprising that these prolonged influenzal pneumonias should be looked upon with a suspicion of being tuberculous. If they are not tuberculous originally—and as a rule they are not—they present a *locus minoris resistentiae* where the ubiquitous tubercle bacillus may find fruitful soil. For that reason alone, great care should be exercised in the first place in making the diagnosis, and second, against condemning an individual to the category of and association with tuberculous patients on physical signs alone. The important point for differentiation is, as has been repeatedly noted, that the streptococcic and the so-called influenzal pneumonias are essentially *basal* in distribution. Although occasionally lesions due to these organisms have been encountered in the upper lobes, they never involve the true apex. The few of the upper lobe type that we have seen and which have suggested tuberculosis have completely cleared up under observation within three to four months.

(B) Perhaps the most important group of cases which have come to our attention has been that in which the *x*-ray demonstrated the occurrence of an acute peribronchial infiltration and mediastinal adenitis. Twenty-six cases have been collected because they showed a persistence of adenitis, varied in extent, and because of certain sequellae they presented, which in all probability have a definite bearing upon their subsequent history.

These cases, however, were not the only ones which showed adenitis. Where the pneumonic lesion was not so extensive as to obscure the view, it was noted that the mediastinal glands were more or less affected in most instances. The waxing and waning in size of these could be observed daily, concomitant with the progress and recession of the pneumonic process. Not, infrequently, also, in the unilateral cases were seen a hemorrhagic pneumonitis in one lower lobe and an acute mediastinal adenitis on the side opposite to the pulmonary lesion, as well as on the affected side. In addition, fourteen cases showed an acute root adenitis only, without any pulmonary infiltration. Clinically, those patients either had an acute bronchitis of the larger tubes which was not radiographable, or else absolutely no physical signs that could be detected on routine examination. They were regarded as ordinary influenzas. As we look back now, in the light of our present knowledge, we believe that we must have missed a good many influenza cases in whom, in all probability, an acute adenitis was overlooked because *x*-rays were not done during the early epidemic days. And the asthenias, the loss of weight and the depression which were seen, but to which no obvious cause could be assigned, were in all likelihood due to absorption of toxins from unresolved glands. The entire picture, in a word, was analogous to an acute tonsilitis with a secondary cervical adenitis, or a simple primary acute adenitis such as appears quite often in children after exanthematous diseases. Later on in the epidemic, when information was received that an acute adenitis obtained,

more careful examination revealed not infrequently increased whispered voice sounds and bronchial type of breathing close to the spine along the upper thoracic vertebra. Apparently D'Espine's sign, useful in the diagnosis of tuberculous adenitis, served equally well in influenza. These findings are not at all strange; they correspond to the natural state of affairs which we see every day in glands draining inflammatory areas in obviously accessible locations. The autopsies of 100 patients showed, in the greater percentage of cases, more or less involvement of these glands. In seventeen cases where cultures were made, the organisms which were recovered from the lungs were identical with those obtained from the glands, thus:

Pneumococcus	9 times
Hemolytic Streptococcus	7 "
Bacillus Friedlander	8 "
Staphylococcus	3 "
Influenza	1 "

It would seem from these that the lymph glands apparently either harbored the organisms which caused the pneumonia or else the organisms invaded the glands secondarily. In this last instance, it would be held that the lung was the source, the infection there having been induced either by direct transmission through the bronchi or by the blood stream. If, on the other hand, the first holds true, namely that the lymph glands were the source, then the small number of positive blood cultures obtained (only 14 out of 200) and the multiplicity of organisms found in lungs, may prove one of its explanations. Here the assumption would be that the organisms were transmitted through the lymphatic system and arrested in the lungs, not enough escaping into the blood stream to produce a septicemia. It is a well-known and widely accepted fact that the tubercle bacillus not infrequently starting in the tonsils passes down the cervical glands, thence through the mediastinal glands, the thoracic duct and right heart, and finally invades the lung through the lesser circulation. Why not the pneumococcus, streptococcus or influenza bacillus?

Sections of lung stained for bacteria in situ have frequently shown pulmonary lymphatics full of organisms. This has recently again been corroborated by MacCallum in his study of streptococcic lesions in influenzal pneumonia. It is evident, therefore, that an inflammatory process must be going on in the lymphatics and mediastinal glands as well as in the lungs where these same organisms are found.

If, on the other hand, the bacteria are secondary invaders of the lymph glands, then the next question which arises is, in case the patient gets well, what becomes of these? Does the inflammatory reaction which the organisms set up in the glands, as evidenced by their hyperemia and increased cellular infiltration, subside altogether with the inflammatory condition of the lung, and the organism absorbed? Our *x*-ray studies have to a certain degree answered this question. We have found in the twenty-six cases under consideration that the root adenitis has remained to a greater or less extent thus far from one week to three months after complete recovery. If, therefore, the adenitis does not completely disappear, are the organisms still harbored in these glands? If so, are they responsible for the recurrent attacks of influenza and its pneumonia—pneumonia irrespective of influenza which is so frequently encountered throughout the year in both civil and military life? Are they the causes of persistent, productive pneumonia, and also perhaps accountable for the readiness with which the tubercle bacillus finds its way in certain instances into this prepared field? Again, are the glands with the many organisms which they contain similar to the tonsils, foci of infection, responsible for some of the acute arthritides and pleural infections which have occurred after the patient had presumably recovered from his pneumonia? Occasionally an afebrile period of a week or more has been seen in pneumococcic empyemas following pneumonia. It is difficult to establish all these points, because of necessity the glands are inaccessible for cultural purposes *intra vitam*. Yet if by subsequent history

and with the aid of the *x*-ray such things can be followed up, valuable data may be adduced in support of this contention.

As corroborations of this hypothesis a number of type cases have been collected and are hereunto appended.

Acute Influenza with Adenitis Only, Preceded by Pneumonia:

Case 1.—W. J. H., 30116 and 16139. Patient discharged with diagnosis of bronchopneumonia, right base.

June 13, 1918, Temperature between 99° and 100°; pulse 70 to 90. Sputum, pneumococcus type IV. *X*-ray on discharge, negative for pulmonary involvement.[6]

Re-admitted Sept. 28, 1918. Diagnosis, acute influenza. Temp. 103.2° on admission, which lasted two days with a critical fall. *X*-ray on Oct. 9th showing mediastinal glands to be greatly enlarged.[7]

Two Attacks of Pneumonia, February and March

Case 2. A. T. Admitted Feb. 15, 1919. U. S. A. Hospital No. 1, Hoboken, N. J. Diagnosis on discharge, lobar pneumonia, lower and middle right and lower left. Pneumococcus type II.

History: Began 8 days ago on board S. S. Leviathan en route from France. Acutely ill on admission with fever, cough, pain on respiration, pain in both lungs, crisis Feb. 17. Blood count 2/16 W.B.C. 12,400. Polynuclears 76 S. M. 24.

Feb. 21. Continues to improve.

Feb. 26. Continues well.

March 4. Has some pain in right side, otherwise well. Transferred.

March 7. Admitted to Walter Reed General Hospital. On admission, felt well. Complains only of occasional pain on right side when he takes a deep breath, coughs slightly; no sputum; no other symptoms.

Physical examination absolutely negative on admission.

March 11. G. C. good. No physical signs in lungs. No complaints.

March 14. Patient does not feel well. Went out yesterday, suddenly experienced a pain in right chest, temperature up this A. M. 100.2°, pulse 108, respiration 22. Physical examination reveals patch of crepitating râles at the left base posteriorly. Diagnosis: Bronchopneumonia, left base (J. H.). Blood cultures sterile.

March 15. Patch of crepitating râles at the right angle of the scapula.

March 16. Temperature 99.4°. No change in physical signs. Note by Ward Surgeon. Patient is probably having slight recurrence of old pneumonia. W. B. C. 6,800, negative for T.B.

March 22. General condition good. Temperature 98°. Patient up and about. Chest clearing. W. B. C. 8,250. Throat culture H. S. 3 plus. *X*-ray examination: Root adenitis, acute. Lungs negative.

Two Attacks of Pneumonia, root adenitis, Acute Arthritis

Case 3. E. D. W. 19745, 26181. Admitted Sept. 23rd. Diagnosis: Acute Influenza.

Sept. 27. Acute bronchopneumonia, left lower base, chronic mitral regurgitation existed prior to enlistment. Patient very ill. Serious illness slip sent out.

Nov. 14. Improved. Lungs clear.

Nov. 18. Went on furlough for 15 days.

Dec. 6. Returned from furlough. Examination shows a very rapid heart and loud systolic murmur at apex. Transferred to convalescent ward.

Jan. 13. Disability papers prepared and forwarded for action.

Feb. 2. Harsh breathing and signs of consolidation at left base.

Feb. 3. *X*-ray examination: Early involvement of upper portion of left lower lobe, also distinct involvement of root glands on both sides.

Feb. 6. Râles over the left lower lobe disappearing; temperature 99.8°, pulse 88, respiration 22. *X*-ray practically clear of pulmonary involvement.

[6] At that time we did not recognize the significance of mediastinal adenitis.

[7] Hereafter the term acute adenitis will be used.

Feb. 7. *X*-ray report: Except for root adenitis, the chest was practically clear.

Feb. 8. Temp. 100.4°; pulse 84, respiration 22; Chest negative. Patient complained of pains in joints, especially in knees and wrists.

Feb. 9. Chest negative. Temp. of low grade, probably due to joint involvement and adenitis.

Feb. 15. General condition improved. To be discharged from hospital.

LABORATORY EXAMINATION

Sept. 28, 1918. Sputum rusty, muco-purulent, pneumococcus type IV recovered. Blood culture sterile.

Feb. 5, 1919. Sputum shows pneumococcus type II, irregular and hemolytic streptococcus isolated from mouse. Blood culture sterile. Throat and naso-pharynx positive for H.S.

Two Attacks of Pneumonia, Acute Adenitis, Mastoiditis

CASE 4. L. C. Private French Army. 21500. Admitted Oct. 16, 1918. Diagnosis: Influenza, Bronchopneumonia, both bases (Jaundice quite marked).

X-ray, Oct. 25, shows pneumonia involvement at left lower and right lower and part of left upper.

X-ray, Nov. 5, shows chest clear, except for adenitis.

Nov. 10. Recovered, chest negative.

Nov. 11. Pain in left ear. Tenderness over the left mastoid. Left eardrum punctured.

Nov. 13, 1918. Left mastoidectomy. Gas oxygen anesthetic. Mastoid cells filled with pus. Culture positive for H.S. (Pure).

Nov. 15, 1918. Cough, bloody expectoration, dullness and râles over right lower lobe. Diagnosis: Recurrent pneumonia.

Pneumonia, Unresolved, Lasting Four Months with Adenitis and Peribronchial Fibrosis

CASE 5. C. F. 25902. Admitted to Walter Reed General Hospital Feb. 3, 1919.

History: Had meningitis on way to France in September, pneumonia while convalescing. Patient became hoarse during his attack of pneumonia and has been ever since. Diagnosis on admission: Chronic catarrhal laryngitis; sub-acute gingivitis; convalescent from bronchopneumonia of right and left lower lobes.

Feb. 6, 1919. Laryngeal examination, slight swelling of false vocal cords; improving steadily.

Feb. 14, 1919. Medical consultation. Diffuse râles over both lungs, coarse, medium sized, soft, moist. Resonance is diminished over upper lobe, right, anterior and posterior (B.M.R.).

March 10, 1919. G. C. improved. Râles have for the greater part disappeared. Left lower lobe posteriorly still shows many subcrepitating râles. Probably subsiding bronchopneumonia. There is an increased whispered voice within scapular region down to the seventh dorsal and bronchial breathing, probably due to adenitis (H.F.S.).

April 1, 1919. Râles, sub-crepitating and crepitant still persist at left base. General condition improved. Seven examinations of sputum thus far are negative for tubercle bacillus, both by the ordinary and antiformin method. *X*-ray examination shows increased density over middle and lower right, evidence of old right-sided pneumonia, considerable fibrosis and adenitis. Sputum examination, mouse inoculation method, shows pneumococcus type IV, H.S. and Micro. Cattharalis.

Influenza Followed by Pneumonia Succeeded by an Arthritis, Streptococcic Sore Throat and Rash Accompanied by an Acute Bronchopneumonia with X-ray findings of Acute Adenitis.

CASE 6. 24716, B. F. K. Admitted Jan. 6, 1919. Diagnosis on admission: Acute influenza; acute bronchopneumonia, both bases.

Jan. 9, 1919. Complains of pain and tenderness in left knee and ankle. Left knee swollen. No signs of pneumonia at either base.

Jan. 10, 1919. Knee and ankle still

swollen. Urticarial rash over left ankle and left lower thigh.

Jan. 19, 1919. Ankle still sore and stiff. Heart normal. Lungs, clear.

Feb. 10, 1919. Pain in right shoulder still present.

Feb. 14, 1919. Heart irritable. Sitting 108, standing 120. Digitalis administered. Blood pressure 135-90.

Feb. 15, 1919. Left tonsil inflamed. Patient complains of sore throat.

Feb. 18, 1919. Scarlatiform rash over entire body; finely papular in character, discrete, at times confluent, especially in folds of the skin. Throat still inflamed, grayish exudate present on left tonsil. Cervical glands enlarged. Temperature still up.

Feb. 21, 1919. General condition improved. Temperature coming down. Rash fading, no desquamation.

Feb. 23, 1919. General condition not so good this A. M. Temperature up again to 102°. Throat looks much better. Necrotic areas clearing up. Examination of chest shows scattered crepitating râles at right base. Rash disappearing. Involvement of left wrist, which is swollen and red and painful. Diagnosis: Acute infectious arthritis, bronchopneumonia at right base.

Feb. 26. Skin desquamating, left shoulder painful.

Feb. 28. Left shoulder, wrist and left third finger swollen.

March 2. General condition good. Temperature down.

March 4. Para-pharyngeal cellulitis present.

March 7. General condition improved. Throat clearing.

March 17. General condition good. Patient weak. Joints cleared up. Throat negative.

March 21. Greatly improved.

March 23. Furlough 15 days.

LABORATORY EXAMINATIONS:

Urine negative throughout. Blood count 3-17-19, W.B.C. 16,430; 3-17-19, Blood culture sterile, W.B.C. 13,200; 3-22-19, Blood culture sterile, W.B.C. 20,700; Throat culture H.S. 2 Plus.

April 19, 1919. Chest *x*-ray marked adenitis on right side, especially.

Pneumonia Associated with Hemolytic Streptococcus Infection

In going over our *x*-ray films in the later days of the epidemic, we found in certain films a gradual replacement of the smoky appearance which we had learned to recognize as being due to hemorrhagic extravasation in the lung, by progressive discrete mottling. This mottling was observed to occur whenever an interstitial type of pneumonia was present at autopsy. In this group, three cases which demonstrated such a condition were associated with a hemolytic streptococcus infection. The question, therefore, arose whether it were possible that such an appearance could be associated with pneumonias due to certain particular organisms alone, or was it a question of organism associated with the response that the lung makes to infection dependent upon the individual's resistance.

Clinically in these cases nothing new is found in physical signs. By this means it is impossible to differentiate pneumonia associated with a hemolytic streptococcus infection from a hemorrhagic pneumonia with a pneumococcus complicating the situation. Moreover, during this epidemic it was not at all infrequent to find at post the so-called hemorrhagic pneumonitis in one lobe and an interstitial type of bronchopneumonia in another. Consequently, it was hazardous to make a clinical diagnosis of the type of pneumonia that one might expect pathologically. The sputum corroboration was insufficient, because too many organisms were found. The *x*-ray here, therefore, was of supportive value. Of course with the positive blood culture for hemolytic streptococcus, a probable diagnosis of that type of pneumonia was indicated. In one particular case, however, where this obtained, autopsy revealed a hemorrhagic pneumonia of the left lobe and an interstitial on the right, both demonstrable by the *x*-ray.

Turning now to the various complications, such as fluid in the chest, pericarditis, mediastinal empyema, etc., we find here too that our serial *x*-ray studies were of great interest. Occasionally, because of the great quantity of blood in the lungs, physical signs were equivocal. While dullness and bronchial breathing were present, they were nevertheless distant and somewhat suggestive of fluid. This, probably because of the nature of the consolidation, outside of exploratory puncture, was frequently diagnosed by the *x*-ray from the obscuration of the costophrenic angle which in ordinary hemorrhagic pneumonitis was strikingly free from involvement. This freedom also was seen in the apex of the lung and was invariably demonstrated in the plates, repeatedly corroborated by autopsies which showed areas of emphysema along the anterior borders, extreme base and true apices of the lung. The impression one got was that just before the bloody exudate had reached the peripheral portions of the lung, the patient died, and respiration was in the end carried on by the emphysematous lappets of the lung. Hypostasis presumably played a small part, if any. It seemed as if the interplay of vasomotor paresis, extensive hemorrhage, where the patient drowned in his own blood, and toxemia, were largely responsible for rapidity of death.

IV. Bacteriology and Pathology

The bacteriology was done largely under the direction of Colonel Nichols. Our experience has been similar to that of other camps and hospitals. The multiplicity of organisms found has caused us to shift our opinion as to whether the essential underlying etiology is to be attributed to the bacillus of Pheiffer. That this organism has been repeatedly recovered, under normal conditions, is well known. That it has been more often found in this epidemic, associated with pneumonia, has been attested to by certain workers and denied by others. Pritchett and Stillman, as well as many others, apparently adhere to the view that the influenza organism is the cause; on the other hand, equally competent investigators, among them Kinsella,* working in this hospital, seem inclined to the opinion that influenza is caused by an unknown agent. Possibly a symbiosis of the influenza and pneumococcus may be responsible for the frightful mortality. This combination has been reported by many camps. In spite of varying bacteriology, no question has arisen as to the specificity of this disease. The profound depression of the nervous system, the tendency to hemorrhage, the lack of resistance as expressed by the constant leukopenia, the slow pulse, and the characteristic pneumonia, aside from modifications due to secondary organisms, form the basis of this belief.

In reporting the bacteriology, it will, to our mind, be simply a record of the prevailing organisms at this hospital during the the period covered. The pneumonia pictures would be a consequent expression of these; the complications likewise peculiar to the pathogenicity of such organisms.

In the survey of the pathology, 90 autopsies have been collected. Most of these have been preformed by Captain Loyn, to whom we are indebted for permission to study the material. The gross pathology only of 60 cases has been reported on by him. The microscopic appearances of these 60, as well as the gross and microscopic pathology of the remaining 30 cases, which make up this contribution, form important groups for comparison. In comparing them, two factors which may explain the variations observed come to the fore; (a) The duration of life, dependent upon the resistance of the individual, after the onset of pneumonia; (b) The role of secondary invaders. This last was modified primarily by the virulence and consequent predominance of the original infecting agent, and secondarily, by diminution in virulence of the latter, with consequent accession of strength by the secondary invader, varying with seasonal and climatic changes.

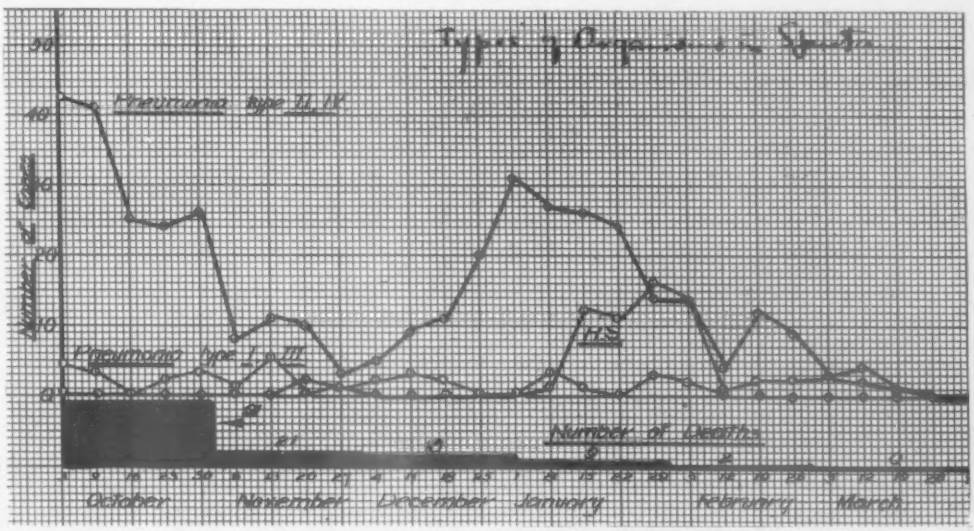
In looking over the histories, it is found that during the months of September and

October, 1918, death took place on an average within eight days after the onset of the disease. From the last part of October through January, February, and March, 1919, the duration of life was between ten and twelve days, even up to twenty or more (one case lasted 165 days). This prolongation of life naturally had a decided bearing on the stages of the lesions.

The key to the second factor is to be found in the study of our chart, recording the sputum examinations from month to month, as well as the cultures obtained from the blood and lungs.

possible general low virulence of the organism in our vicinity supplanted by the greater pathogenicity of the pneumococcus; (b) by the mild weather which prevailed in this locality; (c) by the low resistance of the individual, which brought about his death before the interstitial types of pneumonia occurred.

Turning to the lung cultures of 70 cases, it is again found, parallel with the sputum findings, that the pneumococcus was most prevalent. That organism was recorded thirty-five times, the hemolytic streptococcus twenty-one times, the staphylococcus twenty-three



[This chart is published through the courtesy of Major Simmons, Chief of the Laboratory.]

From the chart it is evident that during October and early November, pneumococci types, II and IV predominated. The mortality during these months was greatest. Then there is a drop until late December, which is again followed by a secondary rise, corresponding to a recurrent wave of influenza during January and February. Here again the pneumococci II and IV are seen in the ascendency, closely followed by the hemolytic streptococcus. In spite of the latter, not many of the pneumonias as such, could be attributed to that organism essentially. The so-called interstitial types produced by the hemolytic streptococcus were indeed few. This may be accounted for: (a) By the

times, the bacillus Friedlander twenty-six times, the influenza eight times.

Blood cultures on 200 cases gave the following results:

Pneumococcus	Type	II.....7	times, mortality	100%
"	"	I.....4	" "	50%
"	"	III.....1	" "	100%
Hemolytic Strep		1	" "	100%
Staphylococcus		1	" "	100%

It is obvious from the small number of positive blood cultures, (although several hundred were taken) that when organisms were recovered from the blood, all barriers were shattered. Their numbers must have been overwhelming.

The combination of pneumococcus, the

hemolytic streptococcus or the staphylococcus in blood cultures, plus the underlying infection, was inevitably fatal. The pneumococcus I was true to the type in its low mortality, in spite of influenza.

Correlating the sputum examinations, the lung bacteriology, and the lung pathology, one arrives at the obvious conclusion that the lungs must have been modified by the presence of pneumococcus as the chief invader, the streptococcus, staphylococcus and Friedlander bacillis as minor. Each one of them, in all probability, stamped its own peculiar pathology on this disease to a greater or less extent. Bearing in mind the pictures, as far as we know them, of pneumonia types which these produce when they are solitary otiologic factors, it has been endeavored to classify the pulmonary lesions accordingly, as far as possible.

PNEUMOCOCCUS TYPES, PLUS INFLUENZA

Pathology.—The general postmortem appearance of the patient who died after an illness of short duration was striking. A marked, blotchy cyanosis prevailed. This was especially evident upon the face, neck, ears and dependent portions of the body. Rigor mortis was present in some, absent in others. From the nostrils and mouth of most of them a reddish froth exuded. At times it was merely a clear brownish thin fluid, varying in amount; at others, it literally poured out, on changing the body's posture. In those in whom jaundice was present, the skin and conjunctivae were a peculiar mixture of yellow and blue. Petechiae were occasionally observed on the neck and part of the chest.

On opening the thorax, the pleural cavity presented characteristic features. There were to be found, in 95 per cent of the cases, fluid in varying amounts. In the early autopsies, it looked like a bloody transudate. It was thin in consistency, pinkish or chocolate brown in color; frequently containing fine flakes of fibrin. Anywhere from 20 to 1500 c.c. were obtained. As a rule, it was most abundant on the side of greatest involvement; more often on the left than on the right. As the epidemic wore on and the influenza became less virulent, secondary invaders were in the ascendency; the character of infection began to change; the fluid become more often purulent. It varied from a slight turbidity to a greenish yellow, creamy, pus. In some of the cases, there was simply a thick, shaggy, greenish, fibrinous layer plastering the pleural cavity, the manubrium of the sternum, and the surfaces of the lung. Occasionally, also, were seen pockets of pus situated between the lobes undergoing encapsulation. In such cases, the pneumococcus was recovered. Where the pus was more fluid, the hemolytic streptococcus was more frequently found, less often the pneumococci.

On removal of the exudate, whether it was bloody or purulent, the constant characteristic findings were hemorrhagic spots, varying both as to shape and size. Some were pin point, others anywhere from one to ten mm. in diameter. Occasionally a fusion of these seemed to occur, and a large hemorrhagic area resulted. These were scattered over the parietal pleura, which was also frequently very hyperemic, sub-pleurally, over the diaphragmatic surface of the lung, between the lobes, and especially over the lower parts of the lobes posteriorly. Not only were they confined to these structures, however, but they were also seen to occur over the parietal surface of the pericardium, more often on the left than on the right side, and at times even over the cardiac muscle itself. Microscopically, these appeared as tortuous, distended capillaries, some of which had ruptured, with consequent exudation of blood cells into the surrounding tissues.

Lungs.—The lungs themselves were very much alike in the early cases. Voluminous, irregularly purplish blue, blood-logged. They pitted on pressure like an edema. The veins, blue black, distended, delineated the lobules. Except for the extreme apex and anterior borders, which were emphysematous, the lungs on the whole were firm. The lower lobes, and posterior portions, were more often involved than the upper, the unaffected parts usually displayed a grayish pink color.

The slaty, purplish areas, on the external surface of the involved lung, had a shotty feel in contradistinction to the light-colored areas, which were soft. On section, large quantities of blackish blood dripped. Scraping the incised surface, which was always moist, a mottled appearance was observed. There were places finely spongy in character, reddish brown, meaty-looking, dark red, slightly raised areas interpolated between lighter gray. These varied in size and shape as well as distribution. Most often in the lower lobes, they could also be seen in any and every part of the lung. Where the process had apparently progressed, lobular areas of consolidation, grayish red, were more often found towards the root than the periphery, which on squeezing, yielded droplets of pus. It seemed as if the lesion here were older. Intervening between the solidified areas were also emphysematous lobules, and atelectasis was noted occasionally. In some lungs, however, the bloody infiltration took almost a lobar distribution; in others, the familiar gray hepatization was observed. Even then a mottled appearance prevailed.

The cut bronchi were often surrounded by the more darkly congested areas. In the early cases, they exuded a brownish bloody fluid, mixed with froth, uniformly thin. In some this was increased in consistency, and in later lungs it varied from a thin pus to a heavier exudate.

The bronchial mucosa, as well as that of the trachea, was thickened, soft, velvety, and intensely red, in the majority of instances. One case presented a diphtheroid pharyngitis.

Peribronchial glands were, in 75 per cent of the cases, swollen, soft, socculent. Their color varied from a reddish brown to black, due in part to anthracosis. The increase in size also differed from slight enlargement to about 50 to 60 mm. in diameter. Some were so edematous that on section the gland substance was almost diffluent.

Microscopic.—The early lungs, in which the pneumococcus prevailed as the chief secondary invader, presented the following:

A. In the first place, no uniformity was observed. All stages of involvement could be seen in the sections. The striking feature throughout, especially in the short lived cases, was paucity of cellular exudate on the whole, and the polynuclears in particular. The relative predominance of mononuclear cells was most notable. It seemed as if the general leukopenia which was so characteristic of the disease, was likewise reflected in the inflammatory exudate, and was part and parcel of the entire pathology. On study of the sections, the alveoli, in some portions, were markedly dilated, and outlined by intensely engourged capillaries. They were filled with mononuclear cells, desquamated alveolar epithelium and red blood cells. The inter-alveolar septa in some places were edematous, and filled with a similar exudate. In certain areas a fine coagulum distended the alveoli; in others, shadows of red cells only remained; especially at the periphery of involved lung. Enmeshing the mobilized cells, was a fine fibrin network, which reached out from air cell to air cell. In places, this was obscured by an inordinate outpouring of red corpuscles from ruptured capillaries which covered everything, confluent lobular, in distribution. Interalveolar septa, the ductuli alveolaris, and small bronchioles were practically obliterated. The bronchioles were often filled with blood. Their epithelium in many places was intact, in some areas necrosed. A peribronchial infiltration of leucocytes was frequently seen ,gradually shading off into surrounding fields, jammed with well-preserved red corpuscles. The blood vessels were likewise engourged. Clumps of pneumococci filled the alveoli, distributed in the exudate. In some sections, especially where the patient had lived longer, there was a tendency of the exudate to change, although the essential hemorrhagic features prevailed. The bronchi were apt to be filled with many polynuclears, interspersed with mononuclears, and endothelial leucocytes, as well as red cells. Here also were seen many large cells, mononuclears, filled with brownish colored pigment, not anthrocotic, but similar to the "Herzfehler Zellen" of Wagner. Interven-

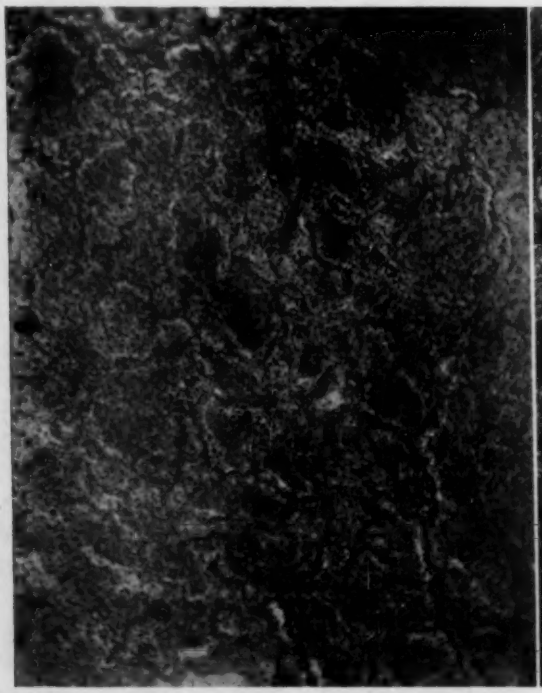
ing between involved lobules were emphysematous spaces. As the process went on, typical gray hepatization could be served.

B. Where the streptococcus had been recovered, as in cases 104a, 117a, 165a, 173a. there was a tendency towards an interstitial broncho pneumonia, plus, of course, the so-called influenza type. This condition has already been emphasized by MacCallum. In our gross sections were noted areas of interstitial inflammation varying with emphysema. One of these cases which lasted 5½ months had in addition multiple bronchiectatic cavities. Micrascopically the branchial walls were invaded with leucocytes largely mononuclear, red blood cells, and desquamated epithelium. Their mucosa was torn away or destroyed in most places. A peribronchial infiltration was invariably seen. The interalveolar septa edematous were also infiltrated with mononuclears and red cells. No marked increase of fibrous tissue was noted. Accompanying these appearances were likewise areas of lobular pneumonia where everything was obscured by a tremendous exudate.

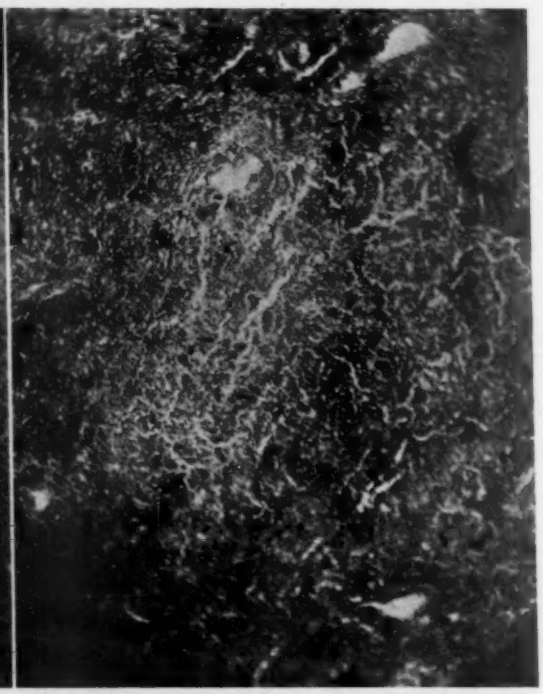
We had four cases where the staphylococcus predominated; one of these had a positive blood culture (180a.).

Grossly, the fundamental characteristic of the influenzal lung, viz., hemorrhagic pneumonitis, the petechial spots over the visceral pleura and lung surfaces, were invariably present. In addition (in 180A) were noted bosses of fibrin 5 to 10 mm. in thickness, covering the purplish colored lung. Cut section revealed the familiar dark reddish brown areas, intermingled with irregular grayish pink areas of consolidation, varying from 5 to 10 mm. Immediately beneath the pleura small abcesses, 5 to 10 mm. in diameter, were evident, others were more deeply situated.

Microscopically all the features of the lungs above described were present. In addition, gradations were seen from areas where polynuclear exudate covered everything, obliterating the alveolar cavities in one



Influenzal Pneumonia with Abcess Formation Due to Secondary Staphylococcus Infection (180a).



Hemorrhagic Pneumonitis with Mononuclear Exudate.

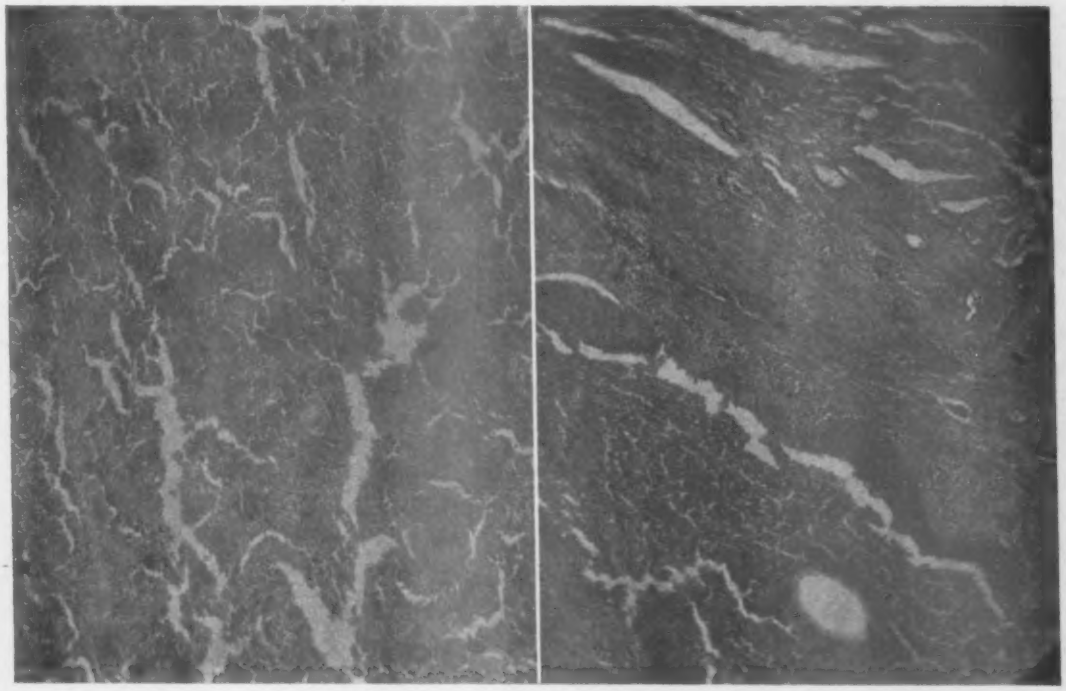
necrotic mass, to fields just covered with blood. Scattered through them were abcesses of various sizes. No attempt at limitation of these by new connective tissue was observed. In some of such collections of leucocytes, degenerated cells and destroyed lung tissue, numerous mononuclears likewise prevailed.

We observed no cases in which the influenza was the only organism recovered. The bewildering complexity of the bacteria made it indeed difficult at times to attempt a classification of the pathology observed. It was obviously perplexing to say absolutely that this or that organism was chiefly responsible for the condition, when two, or even three bacteria operated in the same lung. Although, as it is shown, the Friedlander bacillus was often found, no characteristic lesions such as have been described as pertinent to this organism were ever seen. This bacillus was undoubtedly one of the pre-agonal invaders, and has already been reported on by Nichols and Stimmell.

OTHER PATHOLOGICAL CONDITIONS

The pericardium, in 80 per cent of the cases, showed the presence of fluid. The character varied from a clear serous yellow to a hemorrhagic type. It was bile-tinged, whenever jaundice obtained. Later in the epidemic alternating grades of turbidity, even to a marked purulent exudate, were seen, in a small percentage of cases. The quantity differed anywhere from 2 c.c. or merely a yellow frosting, interspersed with numerous petechiae, associated with dependent thin pus in the bottom of the sac, to an exudate of 400 c.c. In two cases the typical bread and butter appearance was observed. In the majority of instances, purulent pericarditis was associated either with a pneumococcus or streptococcus infection.

Heart.—On the whole, the heart showed very little involvement. In 76 cases, 14 presented moderate dilatation on the right side, one on the left, two, slight hypertrophy of the left. Mitral disease was found in two



HEMORRHAGIC PNEUMONITIS.

INTERSTITIAL BRONCHO-PNEUMONIA WITH BRONCHIACTASIS (173a).

cases. This, however, did not seem of recent origin. The cardiac muscle, as a rule, showed no degenerative changes. Occasionally was seen some athero-sclerosis at the base of the aorta.

The spleen was usually somewhat involved. In the majority of instances, it was soft and flabby, covered at times by very dark red blotches.

The stomach, in most instances, was hyperemic. The fundus, the seat of numerous petechial spots. The duodenum was very often markedly congested. Similar conditions were seen to a varying extent in the rest of the alimentary tract.

The liver was at times enlarged, pale reddish-brown, with irregular yellow mottling, due to moderate fatty changes.

Microscopically, there were present granular degeneration, for the most part, and slight fatty degeneration.

The kidneys were congested and showed cloudy swelling. In sections, granular degeneration and engorgement of the vessels were observed.

The brain presented edema, congestion, and some flattening of the cerebral convolution. Lepto-meningitis was observed in two cases. From one the pneumococcus and staphylococcus were recovered.

The cephalic sinuses were examined in seventeen cases. This was done with the co-operation of the Otological Service. The technique employed was as follows:

After the removal of the brain, the interior of the skull was stripped of dura, and washed with alcohol. The face and reflected scalp was then covered with a towel and the alcohol in the cavity ignited. The sinuses were then opened singly with sterile instruments, and cultures made from the mucous surfaces. In none of these cases, with one exception, were there enough ear or sinus symptoms requiring attention intra vitam. The sinus most involved was the sphenoid. In many there was present a small amount of dark, muco-purulent fluid. The mucous membranes were reddened. In others, yellow muco-purulent fluid was recovered. The presence of this may have added a good deal to the toxemia and cerebral depression. From the point of view of frequency and organisms recovered, the sinus involvements presented the following:

INFLUENZA POST-MORTEM ON SINUSES IN 17 CASES.

	Sphenoid		*Post. Eth.*		*Ant. Eth.*		*Frontal*		*Maxillary*	
	Right.	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*
No. Showing pathological changes	14	13	11	9	5	7	4	5	5	3
Influenza Bac.	1									
H. S.	2	2	2	1		1			3	2
Pneumococcus	6	5	5	4	3	2	2	1	2	1
Friedlander Bac.	4	1	2							1
Staphylococcus albus.	7	3	5	4	3	4	1	1	5	
Pyocyaneus	3	2	1	1		2			1	
Micrococcus catarrhalis		2	1	1	1					
Contaminations.....	2	1								
No Report.....	1									

For the purpose of comparing the bacteriology recovered from normal, uninvolved sinuses, a number of cases were cultured with the following results:

	Sphenoid		*Post. Eth.*		*Ant. Eth.*		*Frontal*		*Maxillary*	
	Right.	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*	*Right.*	*Left.*
No. showing no pathology	3	4	6	8	12	10	13	12	11	13
									not opened 1	opened 1
Influenza Bac.						1				
H. S.		1	1	1	3	1			1	3
Pneumococcus	1	3	1	2	6	3	1	1	1	3
Friedlander	1	2	1	1	3	3	3	2	3	2
Staphylococcus albus.	1	1	2	3	5	3	2	3	8	8
Pyocyaneus				1	3	1	1	1	1	2
Micrococcus catarrhalis					1	1				
No growth	2		2	2	2	2	7	7	1	
Contamination.....						1	1			
No report		1	1	1	1	1	1		1	
No specimen.....									2	2

Summarizing, we find the following organisms:

Staphylococcus albus	65
Pneumococcus	53
Friedlander bacillus	36
Hemolytic streptococcus	24
Pyocyaneus	20
Influenza	8
Micrococcus catarrhalis	6
Contaminations	5
No report	1

An analysis of all these findings makes it obvious that almost all the bacteria which were identified in one way or another, as secondary invaders in influenza, were quiescent inhabitants of the skull, ready to run riot at the least provocation. The question, what are the underlying factors that cause one or another of these organisms to assume pathogenic properties, is still awaiting an answer.

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TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 15. 16, 17 and 18, 1920; at Rochester on the 15th, at Minneapolis on the 16th, 17th and 18th.

Further details and advance information concerning the meeting will appear in these columns from month to month.

Minneapolis headquarters, Hotel Radisson.

MEETING OF EASTERN SECTION AMERICAN ROENTGEN RAY SOCIETY

At the last meeting of The American Roentgen Ray Society provisions were made for the establishing of various sections in different parts of the country. The Eastern Division includes that part east of the States of Ohio, Kentucky, Tennessee and Mississippi. For several years there has been held an annual Eastern Midwinter Meeting at Atlantic City. The section just organized will replace those meetings.

The first annual meeting of the Eastern Section of the American Roentgen Ray Society was held at Atlantic City, Jan. 30 and 31, 1920. This meeting was very largely attended. Papers were read as follows:

Roentgen Ray Economics, Dr. Byron C. Darling. Tumor of a Phalanx, Dr. Howard Ashbury. The Diagnosis and Localization of Non-opaque Foreign Bodies in the Bronchi; Clinical, Bronchoscopic and Roentgenological Observations, Dr. Chevalier Jackson, Dr. Wm. H. Spencer and Dr. W. F. Manges. An Unsuspected Foreign Body in the Bronchus, presenting some unusual features, Dr. David R. Bowen, and Dr. Willis F. Manges. Some Extensive Non-tuberculous Chest Cases, Dr. James T. Case. Observations on Diagnosis of Lung Conditions after Influenza Relative to Tuberculosis, Dr. Isaac Gerber. Roentgen Ray Study of Increased Cardiac Dullness, Dr. Charles L. Martin. Further Observations of Pneumo-peritoneum, Dr. Wm. H. Stewart. Experimental Study of the Duration of Artificial Pneumoperitoneum, Dr. L. T. LeWald. Radium and Roentgen Ray Therapy of Carcinoma of the Cervix and Uterus, Dr. R. H. Boggs and Dr. Charles H. Viol. Roentgen Therapy of Carcinoma Within the Abdomen, Dr. George E. Phaler. Treatment of Thymus

Gland Enlargement in Infants, with Radium, Dr. A. C. Heublein.

Dr. W. D. Coolidge discussed the operation of tubes above voltages of 100,000, and reviewed the foreign literature upon this subject. Dr. A. Howard Pirie described a new instrument for localizing foreign bodies in the eye. Dr. Quimby described a method of agitating the developer in stone devoloping tanks.

Lantern slide demonstrations were given on the evenings of the 30th and 31st.

The constitution and by-laws as provided for by the American Roentgen Ray Society at its last meeting at Saratoga were adopted.

The following officers were elected:

President

Dr. David R. Bowen, Philadelphia, Pa.

Vice-President

Dr. H. M. Imboden, New York City

Secretary-Treasurer

Dr. J. M. Steiner, New York City

DEATH OF DR. F. JAUGEAS

It was with great sorrow that American *x*-ray workers received the sad news of the electrocution of the well known French radiologist, Dr. F. Jaugeas, who met his death while conducting an ordinary fluoroscopic examination of a patient. Dr. Jaugeas was making a screen examination at the little American hospital at Neuilly on the outskirts of Paris. The equipment consisted of a small high-tension transformer built after the model of the bedside instrument used by the American Army in France. From Dr. A. Béclère the writer learns that this small transformer was being worked from alternating current without a rotating rectifier and with a radiator type Coolidge Tube. The *x*-ray room was very small and one of the high tension wires from the transformer to the tube had been allowed to sag lower and lower until in the course of a fluoroscopic examination, while Dr. Jaugeas had his hand upon the metal knob intended for controlling the movements of the tube, contact was established between the high-tension wire and the tube stand, which was not earthed, causing a direct short circuit from the main feed wire through the transformer to our unfortunate friend, who fell with his hand still grasping the tube holder which he pulled down with him. The floor was of concrete, which did not improve the situation. The room was in darkness at the time and the only one present besides Jaugeas and the patient was a surgical colleague of Dr. Jaugeas, who did not understand the working of the apparatus and was unable to turn off the primary current immediately. The instrument in use was not an American instrument; but one built on the type of the American transformer, as above mentioned, in which the secondary high tension wires are in direct connection through the transformer with the primary current. With apparatus of this kind it is important that all the apparatus should be earthed.

Dr. F. Jaugeas.

The tragic death of Jaugeas is an international loss; born in 1880, son of a village school-teacher, he acquired in his home the love of work and study which always animated him. Greatly beloved among his French confrères, his loss was especially felt

by his chief, that dean of radiologists, Dr. A. Béclère. He was first trained in physics and pharmacy, and in 1903 was appointed pharmaceutical interne of the Hospitals of Paris. Here he entered the service of the Hôpital St. Antoine, where he served under Dr. Béclère. Jaugeas' duties as pharmaceutical interne brought him in charge of the *x*-ray laboratory of this hospital under Dr. Béclère, where he at once became enthusiastic over this new science; and during the seventeen years in which he continued this work, except when absent in his war service, he continued as the associate of his beloved teacher, Béclère. His study in medicine began shortly after, and Jaugeas was successively named pharmaceutical interne, externe of the hospitals, and after receiving his degree in medicine, assistant in radiotherapy.

In a recent issue of the *Journal de Radiologie et d'Electrologie*, Dr. Béclère bears touching testimony to the "most fortunate gifts of intelligence, the lively and energetic spirit and the untiring love of work, the most beautiful and attractive moral qualities of Jaugeas."

Our deceased friend's scientific achievements include, among others, a translation of Grashey's "Atlas of Normal Radiography" in 1909. He successfully competed for one of the prizes awarded by the Academy of Medicine and obtained the title of Laureate of this society, his inaugural thesis bearing the title, "Roentgen Ray Diagnosis and Treatment of Hypophyseal Tumors, Gigantism and Acromegaly." This work proved to be fundamental, and it still marks an important advance in the evolution of medical radiology. Dr. Jaugeas was one of the founders and enthusiastic supporters of the Société de Radiologie Médicale de Paris, now known as the Société de Radiologie de France. Later he became a founder of the *Journal de Radiologie et d'Electrologie*. His principal work, a text book on radio-diagnosis (Précis de radiodiagnostic) was a model of simplicity, which at once filled a real need and has come to occupy an important place in the library of radiologists the world over. We most heartily agree with Béclère in acclaiming the deceased as a finished clinician, a learned physician and expert, accomplished in the new specialty, accounted both at home and abroad among the great masters of French radiology.

During the war, Jaugeas served first in the hospital at Marseilles, then at Mans, later with the armies of the field before Verdun, and still later as director general of the radiological service of the French Army in Northern Africa. While serving before Verdun in the hospital at Vadelaincourt he miraculously escaped death during the bombardment of his hospital by German aviators.

We assure our French colleagues, and particularly the family of the deceased, who was personally known to a number of American radiologists who served in France, that we sincerely share the sorrow of their bereavement.

JAMES T. CASE, M.D.

DANGERS IN THE X-RAY ROOM

The death of Dr. F. Jaugeas, referred to elsewhere in this issue of the JOURNAL, led to the publication by Messrs. Watson & Sons of a leaflet entitled "Dangers in the *X*-ray Room," setting out clearly the precautions necessary to insure the safety of operators. This leaflet was recently published in the *Archives of Radiology and Electrotherapy*, and we take the liberty of copying it here.

1. All metal parts of the outfit, such as the switch table, couch, screening stand, tube stand, and particularly the tube box, and handles controlling the movements and diaphragm, should be efficiently earthed. For this purpose a flexible cable is preferable to a rigid wire, which may break or become disconnected. The earth wire should be connected to a water supply pipe, a drain pipe or an earthing plate. Wooden floors are safer than concrete for the operator. Concrete should be covered with some suitable material, such as wood or thick linoleum. Rubber-soled shoes may prevent a nasty accident.

2. When operating *x*-ray tubes there should be no slack wires; all connections should be taught and kept so by a spring.

3. Whenever possible use heavily insulated wires, but even these should always be treated with the same precaution as a bare wire, as the insulation deteriorates in the course of time.

4. All connecting wires and high tension apparatus must be out of easy reach or guarded so that assistants or patients cannot inadvertently touch them.

5. It is most important that overhead wires should be examined from time to time, and precaution should be taken so that a live wire cannot fall on the patient or operator. With this end in view, it is a good plan to place across the *x*-ray room several bare wires connected to earth and at right angles and below the high tension overhead wires, so that should one of these break it is brought into contact with an earthed wire.

6. Periodically examine all wires leading from the high tension apparatus to the overhead high tension cables, and if necessary duplicate the method of fixing.

7. Great care should be taken that all fuses carry only the maximum current required by the apparatus, so that any overload or earth leakage will immediately blow the fuse.

8. When using the Coolidge Tube installation, where the metal extremities of the tube may be close to the patient, it is desirable to provide a cover of metallic gauze, which is connected to earth, so that an involuntary movement may not cause the patient to receive a spark. All metal applicators should also be earthed. Sand-bags will be found useful for checking the involuntary movement of patients.

9. In those *x*-ray rooms which are without a water supply, a special earth plate should be fixed in the ground and an earth wire run round the room so that several earth connections can be easily made.

10. Avoid an arrangement which allows of two pieces of apparatus being simultaneously connected to one high tension source.

11. Never touch the high tension trolley rods without first shutting off the current.

12. Do not install the apparatus in a room so small that it becomes dangerous to move about.

13. Always have a colleague or assistant, if possible, who is familiar with the position of the main switch.

14. When examining and testing an installation do not be satisfied with merely shutting off the main switch on the apparatus, but also switch off at the main supply.

Apart from the above suggestions great care must be exercised in working, because it is impossible to foresee every contingency, and accidents may occur which are not provided for in the above notes.

The *Archives* adds the reminder that the above precautions refer only to high tension currents, and that, in addition, there is constant danger from primary and secondary radiations unless there is adequate protection. The occupants of a room above or below the *x*-ray room may be unwittingly subjected to radiation unless proper steps are taken. The *x*-ray tube should be completely surrounded by lead sheet, not less than 2 mm. thick (preferably more), leaving only the smallest necessary aperture for the beam of rays utilized to emerge.

The need for thorough protection from high- and low-tension currents is very great, and all who are responsible for the safety of workers in *x*-ray and electrical departments will feel with us that the time has come when thorough inspection by electrical experts is essential in all of those departments. Some Federal authority should take the matter up and appoint an expert, who should visit all *x*-ray and electrical departments in hospitals and private institutions, with a view to assuring that the work be carried on under conditions of absolute safety.

NOTICE TO WESTERN ROENTGENOLOGISTS

The summer meeting of the Pacific Coast Roentgen Ray Society will be held at the Catalina Islands, June 17 to 20, 1920.

TRANSLATIONS & ABSTRACTS

STEWART, GEORGE DAVID, and BARBER, WILLIAM HOWARD, New York. The Gastric Hypermotility Associated with Gall-Bladder Disease. (*J. Am. M. Assn.* Vol. 73, No. 24.)

The authors begin with the statement that the stomach is the recognized spokesman for any abdominal condition but more especially for the gall-bladder, duodenum and the appendix. They remark on the difficulty in localizing the disease in any one of the three, and also of excluding the stomach even when a definite diagnosis in any of the above can be made.

They mention two ways of studying the question; the review of recent hospital records and the experimental laboratory from 1911 to the present time. The only cases selected are those that have a complete roentgenographic report based on complete gastrointestinal examination, and confirmed or modified by direct inspection of the open abdomen. The percentages as as follows:Disease of the gall bladder (meaning with or without stone): Hypermotility 68.4 per cent, Hypomotility 0 per cent, Normal 31.6 per cent. Diseases of the duodenum: Hypermotility 55 per cent, Hypomotility 12.5 per cent, Normal 12.5 per cent. Chronic Appendicitis: Hypermotility 55 per cent, Hypomotility 0 per cent, Normal 45 per cent. For comparison a series of experiments of animals gave the following results: Gall bladder stimulation (direct irritation): Hypermotility 61.5 per cent, Hypomotility 0 per cent, Normal 15.4 per cent, Retrostalsis 23.1 per cent. Duodenum (Direct trauma), Hypermotility, 66.7 per cent, Hypomotility 0 per cent, Normal 22.2 per cent, Retrostalsis 11.1 per cent. Appendix (Clamping): Hyperperistalsis 100 per cent, Hypoperistalsis 0 per cent, Normal 0 per cent, Retrostalsis 0 per cent.

They admit that there are many sources of error, as in any review of statistics, and mention the following as the most important: The general condition of the patient, his emotional state, his irritability, the irritability of the stomach at the time and the presence of other foci of disease in the body. They draw the following conclusions:

1. For the past eight years, the records of chronic cholecystitis, with or without cholelithiasis, duodenal ulcer, and chronic appendicitis bearing roentgen-ray notes on the gastric motor function and verified by open operation, disclose gastric hypermotility for gall-bladder disease in 68.4 per cent, for duodenal ulcer in 75 per cent, and for chronic appendicitis in 55 per cent of cases.

2. Experiments purposely carried out on the open surgical abdomen antedating this clinical review give hypermotility for gall-bladder disease in 61.5 per cent, for duodenal trauma in 66.7 per cent, and for appendix disease in 100 per cent of experiments.

3. The motor characteristics of surgical lesions of the stomach are the incisura and pylorospasm (pyloric-sphincter-spasm) in that they probably more frequently occur in the presence of essential disease. Diffuse pylorospasm appears very often "reflexly."

JOHN T. MURPHY.

WOOD, FRANCIS CARTER, and PRIME, FREDERICK. Lethal Dose of Roentgen Rays for Cancer Cells. (*J. Am. M. Assn.*, Vol. 74, No. 5, Jan. 31, 1920.)

The conclusions reached by the authors in their very able article are: 1. Approximately four erythema doses of roentgen ray, given continuously and filtered through 3 mm. of aluminum, are required to kill mouse carcinoma, and five to kill sarcoma exposed in vitro; but occasionally some cells may escape the effects of even six doses.

2. Approximately six erythema doses are required to kill sarcoma cells in vivo as compared to five required to kill the same cells in vitro; and approximately six doses to kill carcinoma cells in vivo, as compared to four required to kill the same in vitro.

3. The in vitro outgrowth from sarcoma tissue after four erythema doses of roentgen ray produced tumors when inoculated into mice.

4. At least five erythema doses are required to kill carcinoma and sarcoma cells in tissue cultures, and at least four to kill embryonic connective tissue cells in cultures.

5. The amount of in vitro growth is no indication as to whether the tumor cell is or is not capable of proliferating in the animal body. The growth observed after lethal doses is evidently due to the slow action of the rays which permits cells potentially dead to wander out into the medium and to complete a division process before their growth momentum is finally checked.

6. Absence of mitolic figures after roentgen ray treatment is not an indication of lack of ability of the cells to grow in the animal body.

7. The practical conclusion which may be drawn from these observations is that the amount of roentgen ray necessary to kill all the cells of a rapidly growing, very cellular, and highly malignant sarcoma or carcinoma in man is between five and seven erythema doses of filtered roentgen rays when the tumor is on the surface of the body. Every centimeter of tissue that covers the tumor makes an additional amount of roentgen ray necessary.

For example when slices of fibroid uterus are used as absorptive material, the galvanometer deflections show that at a depth of 2 cm. 19 per cent more roentgen ray is required; at a 5 cm. depth, 47 per cent more and at 10 cm. depth, 65 per cent more. While many tumor cells may possibly be slowed in their progress and mitotic forms killed at such depths, it is doubtful whether all can be destroyed. The basal-cell tumors and the lymphosarcomas are, as is well known, much more susceptible to radiation. Small superficial, metastatic carcinomas are also, in some instances, more susceptible than is the primary tumor.

They state that soft roentgen rays have a practical therapeutic value only on superficial growths, the penetration being very slight, the spark gap being only from 4 to 8 cm. in the experiments by Kimura. The general tendency at present is to use highly filtered rays with a spark gap of from 8 to 9 inches representing a terminal voltage across the tube of from 80 to 90 kilovolts. When low voltage is used the effective roentgen-ray output from a tungsten target tube is small, the K radiation appearing only when about 70,000 volts are applied to the tube terminals, while a much higher yield is apparent with from 80 to 95 kilovolts.

PIRIE, A. HOWARD, Montreal. The Present Status of Radiotherapy. (*Int. Abstract of Surg.*, Aug., 1915.)

As the terms dose and filtration will be frequently mentioned, it will be well to define what is meant by *x*-ray dose and filtered rays. The unit dose of *x*-rays is known as 10X. This is the quantity which causes epilation. As ordinary light is a mixture of light of varying wave lengths, separable into the colors of the rainbow, so the rays coming from an *x*-ray tube are mixtures of rays of varying wave-length. Those of shortwave-length penetrate the tissue and are called hard rays, while those of long wave-length are non-penetrating and are called soft rays. Both kinds can be used for superficial treatment, but for deep treatment only the penetrating rays, those of short wave-length are of value. Therefore for all deep treatments the non-penetrating rays are removed, so as to prevent injury to the skin and maintain its integrity. This is accomplished by placing a sheet of aluminum from 1 to 3 millimeters thick between the *x*-ray tube and the skin. The rays are then referred to as being filtered.

Cases of splenic leukemia which have ceased to respond to *x*-ray treatment do respond to radium, according to Renon. The difference between the effect produced by radium and *x*-ray may be due to blood passing and repassing during the long application of radium, and so becoming impregnated with its energy. A. David says that radiotherapy produces rapid change in the leucocyte formula, but a time comes when radiotherapy is powerless. By the use of benzol the destruction was checked in the majority of cases, but anemia did not disappear completely, as the drug acts on the red blood corpuscles and hemoglobin. Improper use of benzol is liable to cause lesions of the liver and kidneys.

Parkes Weber reports a case of myeloid leukemia which had already been treated with *x*-ray. The treatment was discontinued and benzol given for 70 days without result. After that *x*-ray treatment was begun again, and marked improvement followed, with dimunition in the size of the spleen and liver, and improvement in the blood count. From a review literature and the writer's personal experience one need feel no hesitancy in

stating that radiotherapy is the best treatment at present known for splenic leukemia.

Radiotherapy in gynecology is of value in hemorrhagic metritis and fibroma uteri. The literature at present is so full of reports of successful *x*-ray treatment of Myoma-uteri and metrorrhagia that the writer feels that he need not enlarge on it further. He has omitted any further comment on the subject. Analysis of these successes establishes the fact that myomata and menorrhagia in women over forty are best treated by *x*-rays, and for younger women it is the treatment of choice where operation is contra-indicted. The writer's experience confirms the results reported. He has seen myomata decrease in size and disappear and menorrhagia cease under *x*-ray treatment, and has also seen it reappear after cessation of treatment. He has seen complete cessation of menstruation follow *x*-ray treatment, and has also seen it reappear after cessation of treatment, after menstruation had been suppressed for three months. In fact the ovaries behave under *x-rays* somewhat as the hairs of the head do. The hairs may be made to fall for two months and then grow again, or may be made to fall out permanently, according to the dosage applied.

The use of radiotherapy in malignant disease may be summed up as follows. When the disease is removable by surgery let the surgeon remove it. When entire removal is not possible let the surgeon remove as much as he can, and leave the way open for radium to reach what he cannot. Surgery may become possible after the use of radium in a case inoperable before its use. Radium should not be looked on as an "also ran" to an incomplete operation; but like a boring in the rock for the reception of dynamite, the operation should be a preparation for the use of radium.

Hayward Pinch recommends one millimeter of silver as the best filter for radium, and urges the protection of healthy tissues, especially in the vagina. Packing with gauze is sufficient protection so as to afford the protective effect of distance. Pinch, who has charge of the Radium Institute in London, with a large quanttty of radium at his command, recommends that every removable carcinoma should be removad by the surgeon. Treatment by radium yields most gratifying results in carcinoma of the uterus, and the effects of this treatment in inoperable cases are far in advance of those obtained by any other known medical or surgical method. He says that the complete disappearance of fungating growth, arrest of hemorrhage and discharge, healing of ulceration, and relief from pain are phenomena of almost daily occurrence. Care must be taken not to use too much radium or destructive reaction may follow. After the treatment the patient must use a douche twice a day in order to prevent adhesive vaginitis. In carcinoma of the breast Pinch is less enthusiastic in his comment. Many patients exhibit a great susceptibility to radium, the primary growth becomes smaller, and infected glands and subcutaneous nodules lessen or even disappear. Little or no effect appears to be exerted in the prevention of metastatic deposits. In a few patients who had been under treatment for two years he noted that a stage was reached in the treatment when the response to radium failed, and the benefit derived became negligible. In Paget's disease he says the superficial lesion is usually speedily cured by radium, but in cases in which the patient is willing to submit to operation, that procedure should always be adopted.

Sarcoma and lymphosarcoma give excellent results from radium treatment, but melanotic sarcoma is uninfluenced by it. It is important to use large quantities of radium inside and outtide of the growths. The best results are secured in sarcomata of the tonsil and the post-nasal space, the growths disappearing completely with six weeks' treatment (Pinch).

Petersen states that *x*-rays have a very varying effect on sarcomata. Some are refractory and increase in spite of *x*-ray treatment, while others show an astonishing sensitiveness to the rays and melt away like snow before the sun. Hitherto it has not been possible to establish the definite relationship between histological structure and radiosensitiveness. Petersen has collected 45 cases of sarcomata, recorded in the literature, reported cured by *x*-rays. These cases are the work of 25 radiologists. Some of these apparent cures must be discounted, but others are undoubtedly cured, have stood the test of microscopic examination, and had no relapse for several years. Cases of fibrosarcoma, round-celled sarcoma, and spindle-celled sarcoma have remained cured for from 3 to 8 years. But it must be admitted that the percentage of permanent cures of sarcoma by *x*-rays is as yet small.

Heineke, at the tenth congress of the German Society of Radiology, gave some suggestions on the biological action of *x*-rays. Tumors have the same sensitiveness to *x*-rays as their parent cells; thus carcinoma of epithelial origin is less sensitive than lymphosarcoma. Periosteal sarcoma is very refractory to *x*-rays.

JORDAN, ARTHUR. Eighteen Months' Experience with Radium. (*Northwest Med., Seattle,* Vol. XIX, No. 1.)

The object in writing this paper is to bring to the attention of the general practitioner the everyday use of radium rather than to offer a technical paper for the radiotherapist. The following list of cases treated with radium is given and shows uniformly excellent results: Cancer; By far the greater number of malignant conditions treated by us have been lesions found on and about the face. The most frequent lesion has been the basal cell epithelioma, Lupus Erythematosus, Lupus Vulgaris, Nevus Flammeus, Leikoplakia, Keloids.

Technic. The object of the radiotherapist is to reach the deep layers of tissue without destroying the healthy tissues. It must be understood that they do not tie to any particular technic and are of the opinion that one can get as good results from his own as if he followed that of another radiotherapist. There are certain hard and fast rules which should constantly be kept in mind. For instance, when we speak of the use of radium we should refer to the radium element content in the applicator, and not to an indefinite amount of radium. In malignant diseases we must first attempt to reach the deep tissue, which is accomplished by screening. Later in the treatment we can give the full effect of the radium to the superficial tissues. In the fungating type of epithelioma we give a massive dose. Again, where there are large masses of malignant tissue we employ the cross fire.

ORNDOFF, B. H., Chicago. Pneumoperitoneum in *X*-ray Diagnosis. (*Journal of Roentgenology,* Vol. II, No. 3, Sept., 1919.)

Pneumoperitoneum indicates that the peritoneal cavity has been distended with a medium of a gaseous character. In the early cases air was used, later oxygen and nitrogen have been used. Oxygen seems preferable.

The apparatus used in producing pneumoperitoneum consists of a tank of oxygen, a water-bottle indicator, a pressure gauge, needle, cotton filter, rubber tubing, glass connections, etc.

The needle used may be an ordinary intraspinal needle not less than eight centimeters long. The oxygen may be supplied from an ordinary oxygen tank. The water-bottle indicator is constructed from an ordinary deep, narrow bottle, a double perforated cork and two glass tubes. The inflowing oxygen is conducted by the glass tube about one inch beneath the surface of the water. The outflowing tube passes just through the cork in order to avoid collecting the water thrown up by the oxygen from the inflowing tube. The pressure gauge is an ordinary blood-pressure apparatus graduated to millimeters of mercury. The cotton filter consists of glass tubing filled with absorbent cotton. The cotton filter and rubber tubing connecting with the needle are sterilized in an ordinary formaldehyde sterilizer. The needle is sterilized by boiling.

1. The procedure of producing pneumoperitoneum is not difficult, and while a few important points in technique are essential, they require no special training other than the usual medical training of a physician.

2. The size, position, mobility, relative density, variations in density, contour, contents and cavities of the abdominal viscera can be visualized and studied in a manner which opens to physicians entirely new possibilities.

3. New findings are encountered which seem to invite the conclusions that the basis for possible new clinical disease entities have been established and old clinical entities relegated to obsolete classifications.

4. Peritoneal adhesions between abdominal viscera and the anterior abdominal wall are demonstrated without difficulty. The importance of the functional pathology originating from this source will be studied carefully by the workers in this branch of medicine.

5. Fixation of the gastrocolic omentum to the anterior abdominal wall in seven cases have all shown, as a cardinal symptom, vomiting, which is temporarily relieved by producing a pneumoperitoneum. The symptom returns as the oxygen is absorbed.

6. Perihepatitis, perisplenitis and pericolitis with peritoneal adhesions offer new phases for study of functional pathology of these organs.

7. After pneumoperitoneum has been produced valuable aid in diagnosis is offered by filling the colon, stomach, duodenum, small intestines, bladder and pelvis with oxygen. Variation in the diameter of the walls, changes in relative densities, and the presence of neoplasms are detected before they have reached large proportions, and, consequently, diagnosis and prognosis is rendered more rational and reliable than has heretofore been possible.

8. Post-operative peritoneal adhesions to the anterior abdominal wall may be prevented by keeping the peritoneal cavity distended with oxygen for three to five days, or until the peritoneum is healed.

WEBSTER W. BELDEN.

SCHANZ, ROBERT F. Iodid and Bromid Pastes as Used in Roentgenography. *(J. Am. M. Assn.*, Vol. 74, No. 5, Jan. 31, 1920.)

A serviceable paste should have the following characteristics:

1. It should be non-irritating.
2. It must be thick enough at body temperature, to be retained when injected.
3. It must be free from small lumps, as often it is desired to pass it through a medium-sized needle.
4. Its base should be water-soluble so that it can be easily washed from an injected area.
5. It should be easily prepared and preserved.

The author, after experimentation, found that the three following were most serviceable:

Corn starch is suspended in water and is then placed in the water-bath. It is stirred continuously until a thick paste is formed. Glycerine is then mixed in thoroughly—this forms a glyceride of starch and also prevents the surface film from forming when the paste cools. Then add 15 gms. of iodid or 25 gms. of bromid. These go into solution readily without the addition of more water.

Corn Starch	10 gm.
Glycerin	16 cc.
Water	100 cc.

is the formula of starch paste.

To preserve the paste and render it unfit for bacterial growth when harbored in a tract, 0.5 c.c. of pure phenol or 1 c.c. of a volatile oil, such as oil of thyme, is incorporated. To help the surgeon in following out the tract at the time of operation, the paste is colored a deep blue with a solution of methylene blue.

Irish Moss Paste

Irish Moss	3 gm.
Glycerin	6 c.c.
Water	100 c.c.

The moss is first well washed in cold water, then placed in a beaker, the water is added and the whole placed on the water-bath for fifteen minutes. It must be stirred frequently. The resulting mucilage is strained through muslin, the glycerineadded and the mixture then heated over the water-bath until a thick, jelly-like paste is formed. Then the iodids or bromids and the phenol are added. This paste seems difficult to color.

Tragacanth Paste

Tragacanth (powdered No. 1)	5 gm.
Glycerin	8 c.c.
Water	100 c.c.

Water is added to the tragacanth, the mixture stirred thoroughly and allowed to stand for twenty-four hours. Then the glycerine is mixed in. It is heated on the water-bath for about thirty minutes. This is sufficient to make a thick, jelly-like paste. Then the procedure is the same as in the other pastes.

The simple inorganic salts of iodin and bromin are better and less expensive than the complex organic compounds. The starch paste is the most economical, is quickly prepared, and is very serviceable. The pastes made from tragacanth or Irish moss are more elegant but are more difficult to prepare. The air bubbles found are easily driven off by heat.

They are all non-irritating, are retained sufficiently long to allow of roentgenography and can be easily washed away by a stream of warm saline solution.

FUSSELL, M. H., and PANCOAST, H. K. A Roentgen Ray Sign of Perinephritic Abscess. *(Am. J. M. Sc.*, Vol. CLIX, No. 574, Jan., 1920.)

A curious fluoroscopic finding was observed in two patients. This sign was that the patients in the erect position when fluoroscoped showed a fluid level below the diaphragm. Grasping the patient's shoulders and moving his body from side to side quickly two or three times, produced a distinct wave in the supposed fluid. This could be very clearly seen on the fluoro-

scopic screen. This was explained by Dr. Pancoast as a collection of fluid around the left kidney, which showed waves on its surface when agitated. In both cases the renal region was opened and a huge sac of pus demonstrated within the capsule of the kidney.

In one case—the second—it was noted that with the patient prone the left diaphragm was shown to have its normal arch, and revealed no evidence of fluid below the diaphragm. With the patient erect, however, the left diaphragm was flat and immobile, and had lost its normal arched position. The diaphragm was not observed in the first case.

Of necessity, pus about the right kidney will not be expected to give this sign, as the liver intervenes between kidney and diaphragm.

ROBERTS, DUDLEY. Certain Limitations of Roentgen Ray Diagnosis of Gastrointestinal Diseases. *(J. Am. M. Assn.*, Vol. 73, No. 20, Nov. 15, 1919.)

The roentgenologic diagnosis has developed with such marvelous rapidity that a great degree of caution should be observed in directing attention at the present time to its seeming limitations. It must be conceded that roentgenology has put gastro-intestinal diagnosis on a new and sounder basis, changing to a great degree the current conception of the meaning of abdominal complaints, and demonstrating some abnormalities with unerring accuracy. Nevertheless there are definite limitations to the extent to which this method can be used.

By roentgenographic examinations we can visualize the shape, size, contour and position of the various parts of the gastro-intestinal tract when properly filled with opaque substances, and we can with reasonable accuracy roentgenograph the outlines of the liver and kidneys, but it must be admitted that we cannot visualize the changes of the structure of the abdominal organs. A negative roentgen ray diagnosis of a gastro-intestinal lesion should never be regarded as final in the exclusion of gastro-intestinal disease.

The study of the esophagus by the fluoroscopic and roentgenographic method has been an important step in the clinical study of its abnormalities, but we must admit that the passage of the meal through the unobstructed esophagus is rapid, and the filling too incomplete to make for satisfactory examination. The differentiation of spasm from annular growth in the cardia is sometimes made with disastrous results. It should be considered merely an aid to other methods of diagnosis of conditions in the esophagus, and not of the same value as in the examinations of the rest of the gastro-intestinal tract, because the esophagus can so readily be examined with the esophagoscope.

The stomach is in many respects the most easily roentgenographed of all parts of the alimentary tract. In only a small majority of cases will adequate fluoroscopic and plate studies fail to show a gross lesion. Ulcers or cancers on the posterior wall of the stomach, unless they encroach on the curvatures, fail on the immediate plate to give definite filling defects. Then there is a definite group of cases that resembl ulcer in history and laboratory findings, while the roentgenographic findings are absolutely negative. The roentgenographic determination as to whether a lesion is active or healed is possible in many cases, and the differentiation between ulcer, cancer and syphilis may also be made with a reasonable degree of certainty.

It is now possible to visualize gallstones in a large majority of cases: and frequently the chronic thickened gall-bladder is definitely shown. All stones and all chronic affections of the gall-bladder cannot be demonstrated. It is not correct to consider the gall-bladder that can be visualized a pathological one.

The diagnosis of ileocecal incompetency can be made by the opaque enema, but the clinical significance is extremely doubtful under such artificial conditions. The roentgenographic diagnosis of appendix has become popular in recent years, although it rests on a very insecure foundation of established fact. The study of the colon is on the whole satisfactory.

NOTE: It might be well to mention the fact that although Dr. Roberts is certainly correct in several of his statements, and all agree that great care must be exercised in interpreting roentgen findings in the gastro-intestinal tract and that this examination is not to be considered all that is necessary in the diagnosis of gastro-intestinal lesion, we still find that the majority of men do not agree with Dr. Roberts in his statements regarding the unsatisfactory examination of the esophagus, and also in his statement regarding the fact that lesions on the posterior or anterior wall of the stomach do not show unless they are of sufficient size to

encroach upon the curvatures, because no gastro-intestinal examination is complete without making plates of the stomach in the lateral position and also fluoroscoping the patients in this position. No doubt a good proportion of the cases mentioned in the article as "a definite group of cases that resemble ulcer in history and laboratory findings while the roentgenographic findings are negative" will be found to be cases of obstruction at the duodenal-jejunal angle (the angle of Tritz) with resulting elongation and dilation of the duodenum. This type of case clears up both clinically and symptomatically when operated upon the operation consisting of freeing the adhesions or doing a duodena-jejunostomy.

WEBSTER W. BELDEN.

TYLER, A. F. Syphilis of the Great Vessels. (*Am. J. Syphilis*, Vol. IV, No. 1, January, 1920.)

Syphilis of the great vessels is so closely linked with aneurysm that the discussion of one is practically a discussion of the other. The literature of this condition dates back to about 200 A. D., when Galen first described aneurysm, differentiating between the traumatic type and the ordinary idiopathic dilatation. At that time, of course, the causative factor was not definitely known, and so every patient in whom an aneurysm is found was considered to have had previous syphilitic infection unless otherwise proved. There are a number of types of aneurysm, the ascending arch of the aorta being the most frequently involved. That part of the aorta above the diaphragm was affected with 75 per cent while 25 per cent of the aneurysms were found below the diaphragm. Of the 75 per cent which occurred above the diaphragm, 60 per cent originated in the ascending portion of the arch. The most frequent type of the ascending portion of the arch is the sacculated aneurysm. Of the descending arch and thoracic aorta, the fusiform aneurysm is the most common. Some one has said that aneurysm of the ascending arch of the aorta is essentially syphilitic, while that of the remaining portion of the thoracic aorta is more apt to be arteriosclerotic. The *x*-ray when used in conjunction with and as an aid to the other means of physical diagnosis has been of great help, especially in making a positive diagnosis of aneurysm of the aorta. The fluoroscopic image should be used in conjunction with the study of properly made *x*-ray plates. When viewing the chest in which one is suspicious of some vascular disease, it is well to study it for a considerable period of time in different positions. My custom is to make a general survey of the chest directly from in front, then to focus down upon the heart and aorta. If there is an increase in the width of the aorta, one can know in which direction this increase extends and can see whether there is definite pulsation. Then the patient should be turned with the rays passing through in the right oblique position, so as to determine whether the increase in the aortic shadow is definitely connected with the great vessels or due to a tumor within the mediastinum. Then the patient should be turned to the left oblique position to see whether it is the ascending, transverse, or descending portion of the arch, or the thoracic aorta, which is the site of the disease. The plates, of course, will give us definite information as to whether there is an erosion of the sternum or vertebrae, because they are more reliable for this information than is the fluoroscopic image. Aneurysm of the aorta must be differentiated from enlarged heart and aortic insufficiency. Since the heart is enlarged in less than half the cases of aneurysm of the aortic arch, one must always be on guard in making a diagnosis of aneurysm when an enlarged heart is found. The aneurysm must be differentiated from a simple dynamic pulsation of the aorta, which is more pronounced in some patients than in others. One of the most frequent errors in diagnosis is when there is a dislocation of the heart due to a curvature of the spine. The physical and *x*-ray findings in this condition are very deceiving, unless one looks very carefully and is very thorough with his examination. Another frequent source of error is in the solid tumor of the mediastinum. One, of course, would not expect to see pulsation in a solid tumor, but it has been my observation in a number of cases that the pulsation of the aorta may be transmitted to the tumor mass, so that one really observes movement of the tumor which corresponds to the beat of the heart. In differentiating tumor from aneurysm I have found considerable help by having the patient swallow a little opaque material, which will show the path of the esophagus and show whether the tumor in-

volves the esophagus or whether there is simply pressure against it. Another source of difficulty in differentiating aneurysm from tumor of the mediastinum is found when the sac has become filled with an organized blood clot. In this type no pulsation will be observed. One must differentiate aneurysm from pulsating pleurisy and from tuberculosis of the spine with an accumulation of tuberculous *detritus*.

KELLY, HOWARD A. and NEILL, WILLIAM, JR. Radium Therapy. (*Am. J. Surg.*, Vol. XXXIII, No. 12, December, 1919.)

He advocates as a method of application the following: if he wants to apply a gram of radium, say inside the uterus, its very bulk in the form of radium salts is a hindrance, so for reasons of convenience as well as security against loss, it is better, when there is enough available to justify the expense of employing a technician, to dissolve all the radium salt in a weak acid solution in a closed glass receptacle; from this its active gaseous principle, called "emanation" by Rutherford is pumped off day by day, with a mercury pump and conveyed to a minute capillary glass tube, which is then sealed, cut off and taken to the patient's bedside to be used. The greater convenience of this method of application will be seen when he states that all of the active material of a whole gram of radium in the form of a salt (which itself would fill a small teaspoon) can thus be accumulated in a tiny intensely active glass button not as large as the head of a common pin. A use that can be made of the emanation, which is of extraordinary value, is by planting it in the tissues permanently in minute capillary glass tubes, each containing from two to three or five millecuries of the gas. A resistent affected gland will sometimes melt down with great rapidity when treated in this way. A most important factor in any successful treatment is the hearty coöperation of the patient. It almost invariably takes time, sometimes several weeks, often when duty and the heart strings are pulling strongly in the homeward direction. The new field of radium therapy embraces: 1. Hodgkin's disease, 2. Myelogenous leukemia. 3. Splenomyelogenous leukemia. 4. Lymphosarcoma. 5. Carcinoma of the inner canthus. 6. Epithelioma of nose. 7. Cancer of the thyroid. 8. Epithelioma of back of head. 9. Cancer of the cervix in three stages. 10. Fibroid tumor. 11. Mediastinal sarcoma. Great and irreparable harm can be done by overzealous, too intensive and prolonged treatments, when even if the patient escapes serious injury, the tissues surrounding or overlying the part being treated may become so irritated that further treatment has to be suspended indefinitely and a golden chance of curing the disease may be lost. What hope is there in the use of radium in cancer of the breast? And what is the best course to pursue in any given case? The decision here involves a fundamental principle in radium-therapy as applied to cancer—namely, *it must be intensive*, it must be a direct application to a given, recognizable lesion, repeated at intervals. It is sufficient to simply spray a lymphosarcoma to dissipate it, but spraying will not do for any form of carcinoma, which must be handled as with a sledge-hammer blow delivered often repeatedly right on the affected spot. The difficulty in a cancer of the breast is this—in an advanced cancer it is manifestly impossible, antecedent to an operation, to know certainly in just how many foci the disease is distributed, and the attempt to treat indeterminate areas of disease violates the principle enunciated, of repeated intensive treatments to each affected spot. Cancer of the neck of the uterus offers the therapist a remarkable opportunity, for the use of radium here bids fair in the near future to drive our surgery entirely from the field. A most precious and fruitful field for radium-therapy lies in the recurrent cancers at the vaginal vault. In "idiopathic" or so-called myopathic bleeding uteri, that is to say in all persistent uterine bleeding without gross demonstrable cause, about the time of the menopause, radium is the one supreme remedy. One of radium's most wonderful fields is the treatment of fibroid uteri; here, perhaps in nineteen out of twenty, we can check the bleeding and stop the growth of the tumor, which shrinks more or less rapidly and sometimes disappears entirely. This, too, may be a matter of one or two brief courses of treatment, external as well as internal.

MEYER, WILLIAM H. Roentgen Therapy in Gynecology. (*N. York M. J.*, January 24, 1920.)

Since the vulva, vagina and cervix may be

classed as superficial structures in so far as the direct application of the rays is a possibility, a classification here need be no different from that of diseases of the skin and tangible mucous membranes in any other portion of the body. Superficial lesions will naturally fall into three groups: 1, those to be benefited by stimulation; 2, those in which an inhibitory action is desired, and 3, those conditions in which total destruction is the aim. Superficial conditions involving the skin and adjoining mucous membranes might properly be left for consideration in the field of dermatology; however, he felt that a few words concerning epithelioma, rodent ulcer, and superficial malignancy should be considered. The possibility of cure of superficial malignancy by radiant energy is practically conceded in every quarter. A significant point is that since employing the absorption rate as a basis for our dose measurement we have passed our fiftieth consecutive case of superficial malignancy, with satisfactory results. In some of these cases the patients are now in their third year following the first treatment, and to all appearances remain permanently well, differences in penetration and filtration are employed to suit the individual case. The estimated absorption, however, is the dose factor in each instance, and the results have been uniform whether the lesion was purely cutaneous or at the mucocutaneous junction; whether prickle cell or squamous cell in type. They are now producing this result in a single sitting, the full treatment to a single area requiring not more than fifteen minutes. A summary means just this, that complete resolution is to be expected only if a lesion is so situated that the dose known to be destructive to the particular type of cell can by multiple area cross-fire be brought to bear. In malignancy, superficial or deep, the desired result will have been obtained under the following conditions: a, Destruction of the malignant cells; b, inhibition to neighboring unhealthy tissue; c, stimulation to the surrounding normal and healthy tissue. In deep seated and more widespread malignancy, usually the very best that one can hope for is: a, An inhibitory action on the malignant cells; b, stimulation of surrounding normal tissue. The gynecological conditions amenable to röntgen therapy may be classed as perhaps a uterine hemorrhage, menorrhagis, metrorrhagia, symptoms of the menopause, and uterine fibroids. A single treatment of from forty to ninety minutes' duration depending upon the size of the patient, a permanent cessation of the menstrual function and of hemorrhage can be produced. When more than one treatment is to be given, from four to six weeks should elapse between applications, not alone to await full reaction, but to allow the skin to recover from the cumulative effect of the rays. The fibroid growths best suited to irradiation are the intramural type. The subperitoneal and particularly the pedunculated variety, had best be removed surgically. The submucous or polypoid type of fibroids are practically contraindications to the use of radiotherapy. When complications, and above all malignancy, do not exist, the results are uniformly good. A few words concerning the logic of dosimetry by the estimation of absorption may be acceptable: 1. The amount and pressure of current energizing the röntgen tube can be metered. 2. The quality and quantity of *x*-rays generated are measurable. 3. Various methods of surface dosimetry have been devised. Yet with all these measures combined, though the incident surface dose appear the same the biological reaction may differ, *i.e.*, the more penetrating the rays and the greater the filtration, the less the possibility of reaction with the same full measured incident dose.

KNOX, ROBERT. Examination of Liver, Gall-Bladder, and Bile Ducts. (*Arch. Radiol. & Electroth.*, No. 228, July, 1919; No. 229, August, 1919; No. 230, September, 1919; No. 231, October, 1919.)

The recorded observations of workers in various parts of the world, notably—Thurston Holland in England, Ledoux Lebard in France, Carmen and Miller, Leonard and George, and J. T. Case in America, and McLeod of Shanghai—gave cause for thought and led to a careful study of the literature of the subject, the technique employed, and a critical examination of the radiograms published.

This was followed by experimental work with calculi, comparisons of densities on tissues absorption of radiation, and particularly the inquiry into photographic processes employed. The investigations were carried out under the following heads:—

(1) Anatomical considerations.

(2) Pathology of gall-stones, and classifications in chemical compositions.
(3) Experimental investigations on absorption, coefficients of gall-stones and surrounding tissues.
(4) Radiographic appearance of gall-stones.
(5) Technique of the examination.
(6) Situations in which gall-stones may be found.
(7) Differential diagnosis.
(8) Pathological gall-bladder.
(9) Record of cases.
(10) Résumé of the literature and general conclusions.

The author considers the anatomy of the liver and gall-bladder in a brief but very comprehensive manner:—

Gall-stones,—these are of frequent occurrence, especially in people of middle age and those of sedentary habits; but they may occur at any age. They occur more frequently in females.

The calculi occur singly or in numbers. Of the solitary gall-stones there are two principal varieties, which are—the oval, composed almost entirely of cholesterin, and second, acorn-like masses, which are composed of cholesterin, bile-pigments, etc.

For best classifications of gall-stones the author quotes from Adami's Pathology. He, after experimental investigation on the absorption coefficient of various constituents of gall-stones and comparisons with the tissues around the gall-bladder area—arrives at the conclusion that it should be the routine practice to expose several plates to the radiation of tubes of different penetration, and to develop the plate to give the maximum of contrast. For this purpose he found that tubes of moderate vacuum gave negatives showing greater contrast than those of higher vacuum.

After the experimental work of the radiographic appearance of gall-stones removed from the gall-bladder or bile ducts, the author finds one point impressed upon the mind—that is the fact that in no instance have the rays actually failed to make an impression upon the plate.

He finds further that stones composed of pure cholesterin when super-imposed upon the liver tissues cast no shadow. He states that in the experiments and photographic records of gall-stones and kidney stones, showing the variation and density with the exposure of tubes of different vacuum, that by the use of the penetronometer it was possible to ascertain the absorption of coefficients of each group.

In his detail experiments, carried out to ascertain the absorption equivalent of gall-stones, he mentions many good points and states that, as a rule, a stone of average density will show through sixteen millimeters of aluminum—which thickness of aluminum he found absorbed approximately the same amount of radiation as the human tissues in the gall bladder region.

Another point of interest noted was—that sixty-five per cent. of the unfiltered radiation is absorbed by the first inch of tissue, while at a depth of two inches the total absorption is ninety-one per cent. of the unfiltered rays against seventy-seven per cent. of the filtered rays. At two inches in depth the curves practically meet for the two types of rays, and proceed onward together. This clearly demonstrates that the rays from a very soft tube can have very little photographic action when they are passed through the tissues of the bodys, as they must be when *x*-raying for gall-stones.

In his discussion of technique for the examination of the liver, gall-bladder, and bile-ducts he lays especial emphasis on the important subject of preparation of the patient, which is now practiced by all Roentgenologists, and the salient points of which all thorough carthax is no solid food is to be taken the morning of the examination, and holding of the breath while exposure is being made. He differs from most Roentgenologists in rather prefering that the bowel be distended with gas than otherwise.

Under the head of position of the patient he advocates:—

(a) Patient prone, with plate beneath the anterior abdominal wall, tube behind the patient.
(b) Patient supine, the plate on the posterior aspect, and the tube in front of the patient.
(c) The lateral position.

In discussing the lateral position, he mentions the great value of it in making a positive diagnosis between gall-stones and renal stones, and says further that no examination of these regions is complete without a lateral plate.

He then takes up in a most interesting and

comprehensive manner the differential diagnosis and positions in which gall-stones are to be found.

In his able discussion of the pathological gall-bladder, he mentions the conditions which can be diagnosed by the Roentgen rays as stone, adhesions, distended gall-bladder containing mucous or mucopurulent material; all of which, from their frequency, are well understood by all Roentgenologists. He states that in exceptional cases a normal gall-bladder, distended with bile, may be shown. Some of us will readily agree, while perhaps the majority will disagree, being of the opinion that a gall-bladder which shows a shadow is pathological.

He then takes up at length the clinical side of these cases and shows many interesting illustrations.

He also goes into other conditions, which he has been able to diagnose with the Roentgen rays: among which he mentions—Hydatid cyst of the liver and sub-diaphragmatic abscess and neoplasm. The latter only can be diagnosed as a tumor, and no differential diagnosis made.